REPORT OF THE PROCEEDINGS

OF THE

TWENTY-FOURTH ANNUAL CONVENTION

OF THE

AMERICAN RAILWAY

Master Mechanics' Association

HELD AT

CAPE MAY, N. J.

JUNE 16, 17 AND 18, 1891.

EDITED BY
ANGUS SINCLAIR.

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1891

AMERICAN RAILWAY

MASTER MECHANICS' ASSOCIATION.

Officers for 1891–92.

PRESIDENT,

JOHN MACKENZIE,

Cleveland, O.

FIRST VICE-PRESIDENT,

JOHN HICKEY,

St. Paul, Minn.

SECOND VICE-PRESIDENT,

WILLIAM GARSTANG,

Richmond, Va.

TREASURER,

O. STEWART,

Charlestown, Mass.

SECRETARY,

ANGUS SINCLAIR,

NEW YORK.

PROCEEDINGS.

PRELIMINARY.

The Twenty-fourth Annual Convention of the American Railway Master Mechanics' Association was held at Cape May, N. J., on June 16th, 17th and 18th, 1891, President Mackenzie in the chair.

President Mackenzie called the Convention to order at 10 A. M., and requested the Rev. George Royal to open the proceedings with prayer, which was done.

THE PRESIDENT—Permit me to present to you Senator Reyburn, of Pennsylvania, who will deliver the opening address.

ADDRESS OF WELCOME.

SENATOR REYBURN—Gentlemen, I think the President has rather misstated it. I do not intend to bore you with an address to-day. You are assembled here for work. I was selected, as I understand, simply to welcome you to this place, and, when your labors are over, to all its enjoyments. You will find in many respects that nature has done much for it, and you will go away, I think, with pleasant recollections of this spot. I have thought much of what a Master Mechanic is, and of course my thoughts have traveled over many years and many nations, and I have thought of the achievements of the Master Mechanics and the workers who have preceded you, gentlemen, and who have left their marks upon the pathway of nations through the ages that have passed before us. But I recognize

that to-day is a day of activity and a day of progress, and that you, gentlemen, are assembled here as the embodiment, so to speak, of that progress. The interests that you represent enter into the lives of the people more, I might almost say, than the Government itself. But certainly, next to the Government, the interests that you gentlemen are allied with enter into the lives and the welfare of the people. I have read with a great deal of pleasure the objects of your Association, as set forth in Article II of your Constitution. It strikes me that if that article could be set before the people of the United States it would remove many of the prejudices and much of the feeling that is expressed by unthinking men against the great railroad interests of this country. I would like to read that article, because it has struck me with peculiar force: "The objects of this Association shall be the advancement of knowledge concerning the principles, construction, repair and service of the rolling stock of railroads by discussions in common, exchange of information, and investigations and reports of the experiences of its members, and to provide an organization through which the members may agree upon such joint action as may be required to give the greatest efficiency to the equipments of railroads which is entrusted to their care."

It strikes me that in a government like ours, a government by the people and of the people, any one will see who reads carefully the reports of the discussions and proceedings of the previous Convention, that that is not an empty phrase —that your discussions enter into the practical every-day appliances that are used; and it seems to me that if there is anything that is for the interest of the people, for the welfare of the public, that you have brought experience, and greater experience than any other body of men could bring, to solve the questions that are now pressing upon us.

I see also that all of your committees are organized with reference to this work, and investigations are undertaken upon the appliances necessary to protect life. As I look over the exhibition that is being held here and the display of articles used for railroad purposes, I find that every one of them is

intended to protect life or limb. I think the greatest number displayed there are car couplers. Now, that shows that even among yourselves you are thinking and working constantly and in all lines and in all directions to produce something to save even the fingers of the people who are employed by the railroads; not only that, but to render more safe the lives of the people that ride upon the railroads. I say that this is a great thing. I have only this to add, that it is with great pleasure that I stand before you to-day, and I hope the deliberations that you enter upon now will bring forth good fruits and that when you leave this place you will leave it feeling that you have done well for the interests and the people that you represent.

Wishing you full enjoyment and a safe return to your homes, I say good day. [Applause.]

THE PRESIDENT—The next order of business will be the calling of the roll.

ROLL CALL.

The Secretary called the roll, and found the following members present:

ALDCORN, THOMAS.
AMES, L.
AUSTIN, W. L.
BARNES, D. L.
BARNETT, J. DAVIS.
BARR, J. N.
BEAN, JOHN.
BISSET, JOHN.
BLACKWELL, CHAS.
BOON, J. M.
BROWN, W. A.
BUSHNELL, R. W.
CAMPBELL, JOHN.
CARSON, M. T.
CASANAVE, F. D.
CASEY, J. J.
CHAPMAN, N. E.
CHAPMAN, T. L.
CLARK, DAVID.
CLARK, ISAAC W.
CLOUD, JOHN W.
COOK, JOHN S.
CORY, C. H.
CROMWELL, A. J.
CROSMAN, W. D.
CUSHING, G. W.
DIVINE, J. F.
DOLBEER, ALONZA.
DOWNING, T.
ENNIS, W. C.
ETTINGER, G. T.
FERGUSON, G. A.
FERRY, F. J.
FORNEY, M. N.
FOSTER, W. A.
FULLER, C. E.

FULLER, WILLIAM.
GARRETT, H. D.
GARSTANG, WM.
GENTRY, T. W.
GIBBS, GEORGE.
GLASS, J. C.
GLOVER, J. B.
GRIGGS, ALBERT.
HARDING, B. R.
HASSMAN, WM.
HEDLEY, E. M.
HEDLEY, F.
HICKEY, JOHN.
HIGGINS, S.
HILL, JOHN A.
HODGMAN, S. H.
HOLMAN, W. L.
HUDSON, E. E.
HUFSMITH, F.
JACKSON, O. H.
JOHANN, JACOB.
JOUGHINS, G. R.
KUHLBAUGH, I. N.
LAUDER, J. N.
LAWLER, F. M.
LEACH, H. L.
LEEDS, PULASKI.
LEWIS, WM. H.
LOSEY, JACOB.
LUTTGENS, H. A.
MACKENZIE, JOHN.
MAGLENN, JAS.
MARSHALL, W. H.
MAY, EDWARD.
McCRUM, J. S.
McKENNA, JOHN.
MEDWAY, JOHN.
MEEHAN, JAMES.
MICHAEL, J. B.
MILLEN, THOMAS.
MILLER, W. H.
MILLS, STOTT.
MONKHOUSE, H.
MONTGOMERY, WM.
MORRELL, J. E.
NOBLE, L. C.
PATTERSON, J. S.
PAXSON, L. B.
PECK, PETER H.
POMEROY, L. R.
PORTER, JOSEPH S.
PRESCOTT, G. H.
PRINGLE, R. M.
PURVIS, T. B., JR.
QUACKENBUSH, A. W.
REYNOLDS, W. W.
ROGERS, M. J.
ROSS, GEO. B.
RUTHERFORD, WM.
SCHAEFFER, AUG.
SETCHEL, J. H.
SEWARD, J. P.
SHAFER, J. C.
SHAVER, D. O.
SHAW, THOMAS.
SHEAHAN, J. F.
SHEER, JAS. M.
SILVIUS, E. T.
SINCLAIR, ANGUS.
SMALL, W. T.
SMART, C. E.
SMITH, GEO. W.
SMITH, WM.
SMITH, W. T.
SMITH, JOHN Y.
SMITH, W. A.
SPRAGUE, H. N.
STAMELEN, F.
STEVENS, GEO. W.
STEWART, O.
STINARD, F. A.
STOUT, HENRY K.
STRODE, JAMES.
SULLIVAN, J. J.
SWANSTON, WM.
TANDY, H.
THOMAS, C. F.
THOMAS, W. H.

TURNER, CALVIN G.
VAUCLAIN, S. M.
WALDEN, W. A.
WARREN, BERIAH.
WATTS, AMOS H.
WEISGERBER, E. L.
WELLS, REUBEN.
WEST, G. W.
WHITE, A. M.
WIGHTMAN, D. A.
WILLIAMS, E. A.

THE PRESIDENT—The next order of business will be the reading of the minutes of the last meetings.

SECRETARY SINCLAIR—The minutes of the last meeting have been presented to the members in due form, and the usual course is to accept them without reading if a motion be made to that effect.

MR. LAUDER—I move that the reading of the minutes of the last meeting be dispensed with, and that they be approved as published in our annual report.

The motion was carried.

PRESIDENT'S ADDRESS.

The President read the following address:

To the American Railway Master Mechanics' Association, its Members, their Ladies and Friends:

Permit me at this, the Twenty-fourth Annual Meeting, to welcome you. I congratulate you upon the prosperous year just passed. At no previous time have the railroads been called on to perform such a large volume of business, and at no time have they been compelled to do business with so small remuneration for the work done. Competition and public demand for cheap transportation have kept the rates so low that good management has been necessary to prevent the business being done at a loss. The mechanical departments have been called upon to perform the lion's share in reducing the actual cost of transportation. The response has been in renewed efforts to make a ton of coal perform increased duty in the movement of cars. Progress in this direction has gone on steadily. The progress of reducing the cost of transportation of freight has called for constant increase in the weight and capacity of cars in order to make the proportion of dead weight to paying load as low as

possible. Locomotives are being made heavier to keep pace with and to reduce the cost of moving cars.

There are two ways in which motive power officers can decrease the cost of transportation. These are, the making of locomotives more economical in the use of fuel, and the reducing of the wages account by making them pull heavier trains.

Fuel is the most expensive item in motive power accounts, and it naturally receives the greatest attention. The efforts to reduce the consumption of fuel have led to decided improvements in the proportions of locomotives. In the past, when little attention was bestowed upon the economical use of fuel, the tendency was to make the cylinders too large for the boiler, with the result that the boiler was intensely forced to generate steam used by the cylinders. This defect is being rapidly corrected. Larger boilers are being applied to over cylindered locomotives, and a striking feature about all new locomotives is the liberal size of boilers. The economy that results from the improved proportions is materially reducing the cost of moving trains, and still there is no disposition manifested by the members to rest and be satisfied that nothing better can be done.

The efforts to still improve the motive power are increasing. This progressive sentiment has been manifested during the past year in the introduction by several railroad companies of compound locomotives, and the results are highly encouraging. The activity of our members in striving to improve the machinery under their charge may be judged by the work of investigation undertaken during the past year.

The reports to be submitted to you at this Convention are more varied than any previously presented, and, as your presiding officer, I would urge that the members discuss them thoroughly.

Your attention is called to the need of action by this Association on safety appliances for locomotives and cars. You are aware of the fact that committees have been appointed by the Railroad Commissioners, and they have had one meeting. They have sent out circulars calling for information under this head-

ing. Two of the important subjects are the "Equipping of Locomotives and Cars with Power Brakes" and the "Automatic Couplers for same." The influence of that committee with Congress will be very great, representing as it does the Railroad Commissioners of all the States. In view of this fact, the members of this Association should see that a more than common responsibility will attach to their action while in convention. I sincerely trust that your body will recognize the importance of the situation and will handle the suggestions seriously and thoughtfully.

The reports of the Secretary and Treasurer will show you that the Association is in a highly prosperous condition, both financially and in number of members.

Since we met last year the Association has experienced an unprecedented increase of membership, there having been added ninety-five members during the year.

The death roll has been mercifully light, but the Association has lost one ordinary member and one honorary member. The ordinary was Mr. S. B. Tinker, who joined the Association three years ago; the honorary member was Mr. S. A. Cummings, who was one of the small group of Master Mechanics that formed this Association twenty-four years ago. Proper committees will be appointed to prepare obituary notices of our deceased members.

A recess of five minutes was taken, after which the President called for the report of the Secretary.

Secretary Sinclair presented the following report:

SECRETARY'S REPORT.

When your Secretary's report was submitted a year ago, there were on the roll 334 ordinary, 15 associate and 14 honorary members, a total of 363. There are now on the roll 430 ordinary, 14 associate and 14 honorary members, a total of 458, and an increase of 95 members. This represents over 25½ per cent. of increase, and is the greatest gain ever made by the Association in one year. There is no reason why all the Railway Master

Mechanics on this Continent should not be members of the Association. The most progressive men of all professions and callings belong to the societies formed for the mutual improvement of the members, and it is probable that our roll of members embraces the most progressive railway Master Mechanics in this country; but there are still many men eligible for membership, who have failed to join because they suppose it is necessary that they should be present at a Convention in order to do so. An effort has been made during the past year to spread the information that those eligible may join at any time on making application to the Secretary, and this has brought to the Association a great part of the increase. If each member of the Association would constitute himself a committee of one to canvass for new members, the roll would soon include the greater part of those who have the right to belong to the organization.

During the past year we have lost by death one ordinary member, S. B. Tinker, and one honorary member, S. A. Cummings; one ordinary member has resigned, and one associate member has been dropped for non-payment of dues. The case of this associate is worthy of special attention, as it is representative of others. At the Convention where he was elected, this associate used the privilege of his connection with the Association to make a lengthy address on the floor of the Convention, advocating the merits of a patented device. After that he appeared to take no more interest in the Association, and in due course permitted himself to be expelled for non-payment of the small annual dues.

The annual report was published in the usual form, 1,600 copies having been printed. By direction of the Executive Committee, your Secretary prepared and had printed a general index of the annual reports, which was distributed to the members who desired to have it.

The money received during the year amounts to $2,555.00. Of this sum $1,502.00 was raised from annual dues, $1,020.00 from contributions to the printing fund, and $33.00 from the sale of annual reports. The contributors to the printing fund are as follows:

Allegheny Valley	$10 00
Atchinson, Topeka & Sante Fe	10 00
Atlantic & Pacific	10 00
Atlantic Coast Line	10 00
Baldwin Locomotive Works	25 00
Baltimore & Ohio	10 00
Boston & Albany	10 00
Brooks Locomotive Works	25 00
Central Vermont	10 00
Chesapeake & Ohio	10 00
Chicago & Alton	10 00
Chicago, Burlington & Northern	10 00
Chicago, Burlington & Quincy	10 00
Chicago & Eastern Illinois	10 00
Chicago & Northwestern	10 00
Chicago, Milwaukee & St. Paul	10 00
Chicago, Rock Island & Pacific	10 00
Chicago, St. Paul, Minneapolis & Omaha	10 00
Cincinnati, Hamilton & Dayton	10 00
Cincinnati, New Orleans & Texas Pacific	10 00
Cleveland, Akron & Columbus	10 00
Cleveland, Cincinnati, Chicago & St. Louis	10 00
Cleveland, Lorain & Wheeling	10 00
Colorado Midland	10 00
Columbus, Hocking Valley & Toledo	10 00
Concord & Montreal	10 00
Connecticut River	10 00
Copiapo	10 00
Cumberland & Pennsylvania	10 00
Delaware & Hudson Canal	10 00
Delaware, Lackawanna & Western	10 00
Denver & Rio Grande	10 00
Duluth & Iron Range	10 00
Duluth, South Shore & Atlantic	10 00
East Tennessee, Virginia & Georgia	10 00
Fall Brook Coal Co	10 00
Fitchburg	10 00

Grand Rapids & Indiana	$10 00
Grand Trunk	10 00
Great Northern	10 00
Houston & Texas Central	10 00
Illinois Central	10 00
Intercolonial	20 00
Iowa Central	10 00
Jacksonville Southeastern	10 00
Kansas City, Fort Worth & Memphis	10 00
Lake Erie & Western	10 00
Lake Shore & Michigan Southern	15 00
Lehigh Valley	10 00
Louisville, New Orleans & Texas	10 00
Louisville & Nashville	10 00
Maine Central	10 00
Minneapolis & St. Louis	10 00
Minneapolis, St. Paul & Ste. Marie	10 00
Mississippi, Kansas & Texas	10 00
Missouri Pacific	10 00
Mobile & Ohio	10 00
Newport News & Mississippi Valley	10 00
New York, Chicago & St. Louis	10 00
New York, Lake Erie & Western	20 00
New York Locomotive Works	10 00
New York & New England	10 00
New York, Ontario & Western	10 00
New York, Providence & Boston	10 00
Norfolk & Western	10 00
Northern Pacific	10 00
Ohio & Mississippi	10 00
Old Colony	10 00
Pennsylvania	10 00
Pennsylvania & Northwestern	5 00
Philadelphia & Reading	10 00
Philadelphia, Wilmington & Baltimore	10 00
Pittsburgh Locomotive Works	20 00
Porter Locomotive Works	10 00

Rhode Island Locomotive Works	$10 00
Richmond & Danville	10 00
Richmond Locomotive Works	10 00
Rio Grande Western	10 00
Rogers Locomotive Works	50 00
Rome, Watertown & Ogdensburg	10 00
St. Paul & Duluth	10 00
St. Louis, Arkansas & Texas	10 00
St. Louis & San Francisco	10 00
Savannah, Florida & Western	10 00
Schenectady Locomotive Works	10 00
Seaboard Air Line	10 00
Southern Pacific	10 00
Terre Haute & Indiana	10 00
Texas & Pacific	10 00
Toledo & Ohio Central	10 00
Western New York & Pennsylvania	10 00
Wilmington & Weldon	10 00

ANGUS SINCLAIR, *Secretary.*

On motion the report was received.

Secretary Sinclair read the Treasurer's report, as follows:

TREASURER'S REPORT.

Cash on hand at beginning of year	$1,080 67	
Interest	2 93	
Received from Secretary Sinclair	2,555 00	
		$3,638 60
Paid Angus Sinclair, Secretary's salary	$1,200 00	
R. W. Ryan, stenographer	134 00	
G. H. Benedict & Co., engravers	82 10	
McGowan & Slipper, printing	195 00	
Advertiser Printing House, printing	589 00	
W. P. Atkins, printing	130 74	
E. Raymond, work on index	120 00	

Insurance on reports	$8 00	
Postage, expressage, telegrams and other expenses of Association	118 01	2,576 85
Balance on hand		$1,061 75

O. STEWART, *Treasurer.*

On motion, the report was received.

Secretary Sinclair then read the report on the

BOSTON FUND.

CAPE MAY, June 16, 1891.

To the Executive Committee of the American Railway Master Mechanics' Association:

GENTLEMEN—As required by the Constitution, I herewith hand you my annual statement of the amount and condition of the Boston Fund, which at this date is as follows:

Four per cent. Government bonds	$6,600 00
Interest for current year	264 00
Interest remaining over from last year	34 13
Total uninvested interest, etc.	$298 13

The amount in currency available for use as proposed at last annual meeting will therefore be about eight thousand two hundred and eighteen dollars ($8,218).

Respectfully submitted,

J. H. SETCHEL,
Custodian Boston Fund.

ASSESSMENT OF ANNUAL DUES.

SECRETARY SINCLAIR—At a meeting of the Executive Committee held this morning it was decided that the annual dues should be five dollars, as usual.

THE PRESIDENT—A motion will be in order to fix the amount of the annual dues.

MR. SPRAGUE—I move that the annual dues be five dollars, the same as last year.

The motion was carried.

AUDITING COMMITTEE.

The President intimated that the election of an Auditing Committee was next in order. The President appointed Messrs. Peck and Swanston tellers, and Messrs. J. M. Boon, W. H. Lewis and H. N. Sprague were elected.

CHANGES IN THE CONSTITUTION.

THE PRESIDENT—The next order of business, gentlemen, will be unfinished business. The Secretary, I believe, has something here.

SECRETARY SINCLAIR—The unfinished business is notices of changes in the Constitution.

MR. SETCHEL—Under this head, I suppose, properly belongs the unfinished business of the last session, that of the disposition of the Boston Fund. It perhaps is not thoroughly understood, and there are several papers to be introduced regarding the matter which will come up before that in the next order of business. I move that that be made the special order for to-morrow at ten o'clock—the disposition of the Boston Fund.

The motion was carried.

CHANGE ON ADMISSION OF ASSOCIATE MEMBERS.

MR. SPRAGUE—If I am in order I wish to call the attention of the Association to a motion that was made last year for amendment of the Constitution with regard to associate members. I notified the Convention that I would make a motion at this Convention to defer action on the applications of associate members for one year. All who have had anything to do with it realize how utterly impossible it is for anybody to make an intelligent report at the Convention without having any time to get information on these matters, and that we are likely to get men on our list of associate members that are not such men as we want nor such men as the Constitution calls for, and I now move that an amendment be made to the Constitution, and that the nominations for associate membership be made one year before being acted on.

MR. SWANSTON—I second the motion.

MR. SETCHEL—Will the Secretary read the clause to be amended?

SECRETARY SINCLAIR—The present article relating to associate members reads:

"Civil and mechanical engineers, or other persons having such a knowl-

edge of science or practical experience in matters pertaining to the construction of rolling stock as would be of especial value to the Association or railroad companies, may become associate members on being recommended by three active members. The names of such candidates shall then be referred to the Executive Committee, and on a unanimous report from that Committee in favor of their election, the names of such candidates shall be submitted to ballot at any regular meeting, and five dissenting votes shall reject. The number of associate members shall not exceed twenty, and they shall be entitled to all the privileges of active members, excepting that of voting."

The amendment of which notice is given is:

"Civil and mechanical engineers or other persons having such a knowledge of science or practical experience in matters pertaining to the construction of rolling stock as would be of especial value to the Association or railroad companies, may become associate members on being recommended by three active members. The names of such candidates shall then be referred to a committee to be appointed by the President, whose report shall be made at the next annual meeting. If the report be unanimous in favor of the candidate, his name shall be submitted to ballot at any regular meeting, and five dissenting votes shall reject."

MR. SETCHEL—Will that affect present applications? I believe there are several.

THE PRESIDENT—I should say that this amendment, having stood over a year, would take effect at once if adopted by the Association, so that it would have effect this coming year.

MR. LAUDER—It seems to me, if this amendment is adopted and incorporated in the Constitution, that it does not and ought not to affect the election of any associate member, if there are any such, proposed at this meeting. It seems to me that this change in the Constitution would not affect this meeting. It is important that the matter should be understood as to whether it takes effect on its passage or whether it takes effect at some future meeting. Now, I think it ought not to and does not take effect at this meeting, because that resolution or that change in the Constitution might be the last thing that was done at this meeting, and in that case could not, of course, bind any action of this meeting. It seems to me clear that this meeting should be conducted under the Constitution as it now exists. It seems to me that is the only fair construction to be put upon the case, and is simply common sense. I hope this amendment proposed by Mr. Sprague will be passed and will be incorporated into our Constitution. I think it is a very wise move and an extra safeguard thrown about the admittance of associate members to this Association. I would say here that that is a matter which the Association must guard with a good deal of care. I claim nothing for myself that I would not grant to every member and every man who wishes to become a member. But

there is a great inducement for any man who has some personal interest to subserve, to try to use all means to subserve that interest; and I know that many—perhaps not many, but some—of our associate members have procured membership in this Association for the purpose of pushing their own private interests, and using the Association for advertising purposes. Now, one of the things we must sit down on is allowing anybody, be he priest or layman, to use this Association as an association for advertising purpcses. [Applause.]

THE PRESIDENT—I would say that any action of this Association would not be retroactive, and if this amendment is passed it will have nothing to do with the action of the Association heretofore; but if it is passed any candidates who are nominated at this meeting will come under the amendment.

MR. SETCHEL—The President has anticipated what I was going to say. I beg leave to differ from my friend Lauder about the time when any action of this Association takes effect. I think, for instance, if we should expel a member, as we have done before now, it would take effect at once and it would be under the By-laws and Constitution. Now, if we pass an amendment before any applications are made, the applications will have to come under that amendment directly, and if we take any other action that affects the welfare of the Association, the effect takes place just as soon as the amendment is passed. There is nothing in our Constitution limiting amendments to any certain meeting.

MR. SPRAGUE—That is the way it occurs to me, and it raises a still further question with me. The candidates who were held over from last year have not yet been acted on. It seems to me, in all fairness, they ought to come in this year if they are to come in at all. But if they are not voted on until after this amendment is passed, they will be deferred another year.

MR. LAUDER—I think the President has ruled on that question and I am perfectly willing to abide by that ruling without any further discussion. It is a matter that really does not affect the welfare of anybody, and it is no hardship for any persons to lie over a year if they want to be associate members.

The motion for the adoption of the amendment was then carried.

CHANGE ON RE-INSTATEMENT OF MEMBERS.

SECRETARY SINCLAIR—The next notice of amendment is from Mr. Mackenzie. It is to amend Section 3 of Article III: "Should cause be subsequently presented for re-instatement of such members, the Executive Committee shall have power to decide the matter."

That is, any one who drops out of the Association for non-payment of dues may be re-instated by the action of the Executive Committee.

THE PRESIDENT—This is the case of men being dropped from the roll for non-payment of dues or other causes. The Executive Committee have no authority whatever now in handling these cases, and if the authority be extended to the Executive Committee they can exercise that authority by re-instate-

ment if they think best. We have several members now who have been dropped on account of non-payment of dues who are anxious to become members again, and there is no way of getting them into the Association and for that reason they are lost to us.

MR. LAUDER—I move that the amendment be adopted by the Association. It seems eminently fair and right and no one can by any possibility, it seems to me, object to it.

The amendment was adopted.

CAR BUILDING WORKS MAY BE REPRESENTED.

SECRETARY SINCLAIR—Mr. Hickey gave notice of this amendment: "I should like to give notice of a change in the Constitution, being paragraph 3 of Article III. I believe it now says 'two representatives from each locomotive building works.' I would like to add 'two representatives from each locomotive and car building works,' so that car constructing works may also be represented in the Association."

THE PRESIDENT—You have heard the amendment offered by Mr. Hickey. A motion to adopt will be in order.

MR. SPRAGUE—Do I understand from that amendment that car builders who are not qualified for locomotive work may be admitted as members?

SECRETARY SINCLAIR—It is that car building establishments may send representatives the same as locomotive establishments.

MR. SPRAGUE—I hardly see the pertinency of that. I do not see why we should have car building represented in this Association. It strikes me that we might just as well take in some other industries. Of course if a man in the car department is a locomotive man, that might have some bearing on it, but for an exclusively car man to be admitted to this Association I should not be in favor of it.

THE PRESIDENT—There is no motion before the house.

MR. BARR—I move that the amendment be adopted. I think the reading should be changed. It says locomotive and car building. It should be locomotive *or* car building.

The motion was carried.

NEW ASSOCIATE MEMBERS.

SECRETARY SINCLAIR—At a meeting of the Executive Committee held this morning four names were submitted of applicants for associate membership. It was voted unanimously to accept Prof. A. T. Woods, W. D. Crosman and W. H. Marshall for associate members. They should be voted upon by the Association now.

MR. PECK—I move that the report be received and the candidates balloted for.

The motion was carried.

Messrs. Peck and Swanston were appointed tellers and the balloting resulted in the election of all the candidates.

TO DRAW THE CONVENTIONS CLOSER TOGETHER.

SECRETARY SINCLAIR—The next business is a report from the Conference Committee about drawing the two conventions—the Master Car Builders' and the Master Mechanics'—closer together. Mr. Stewart is Chairman of the Conference Committee.

MR. O. STEWART, Fitchburg—Members of the Convention who were present last year will remember that notice was given that we should be called upon to change our Constitution and By-laws at the next meeting, so that the time of the meeting of the two Conventions would be brought closer together. The reason given for that was that too much time was consumed in the two Conventions; that there were members of the Car Builders' Convention who wished to remain over and attend the Master Mechanics' Convention; that there were members of the Car Builders' Association who were also members of the Master Mechanics' Association, and that it is very inconvenient and sometimes impossible for them to attend both Conventions on account of the time that they would be called upon to remain away from their business in order to attend the two Conventions. This matter was taken up by the Master Car Builders and a committee was appointed by that Convention to meet with a like committee which should be appointed by the Master Mechanics' Association. Those two committees formed a joint committee. Those two committees met in Buffalo last November. All the members were present excepting Charles Graham.

Mr. Stewart then read the following report.

At a meeting of the committee appointed to confer with a committee of the Master Car Builders' Association the following resolutions were unanimously adopted:

Resolved, That we, the committee appointed by our respective Associations recommend a change in the Constitution or By-laws or both, of each of the Associations, to arrange that the Master Car Builders' Association will meet on the second Wednesday in June, and the American Master Mechanics' Association will meet on the Monday following the second Wednesday in June.

Resolved, That we recommend the change in the Constitution or By-laws, or both, in each of the Associations, so that the officers of each Association constitute a committee of five to jointly fix the place of each annual meeting at least six months

before the meeting, the committee of the American Railway Master Mechanics' Association to consist of the President, two Vice-Presidents, Secretary, and Treasurer; the committee of the Master Car Builders' Association to consist of the President, three Vice-Presidents, and Secretary.

SECRETARY SINCLAIR—In connection with that, Mr. President, I have a letter here from the Secretary of the Master Car Builders' Association indicating the action of that Association in regard to this question. The letter is as follows:

CAPE MAY, N. J., June 15, 1891.

MR. ANGUS SINCLAIR, *Secretary American Railway Master Mechanics' Association, Cape May, N. J.:*

DEAR SIR—The Master Car Builders' Association in Convention on June 9, 1891, received and adopted the report made by the joint committee of the two Associations, as to time and place of Annual Conventions and I am instructed to notify you that the Association of Master Car Builders will meet on the Wednesday following the second Tuesday in June, at such place as the joint committee will determine, if your Association constitutes such a committee with power to act with the committee of five from the Master Car Builders' Association, in accordance with the first mentioned joint report.

Yours truly,

JOHN W. CLOUD, *Secretary.*

MR. SPRAGUE—I move that the report be accepted.

MR. O. STEWART—I am informed that in the deliberations of the Master Car Builders' Association there was one point in this resolution which did not seem at first to be understood. I want every member here to understand before he votes, that this committee which is to be appointed if you adopt this resolution fixes the place of meeting. Now you may say that that takes the business all out of the hands of the Association. That is not the case. The time of this Association is valuable. We have been in the habit of taking a ballot here on three or four or as many places as you choose. Each member could suggest some place where it would be desirable, as he thought, that the Convention should meet. We had the right to vote for any place that we desired and the place receiving the three highest number of ballots was to be

selected as the place of meeting. Now the point we want to make here is this: We want to save this valuable time of the Convention and leave that matter entirely in the hands of this committee, and you are simply putting into the hands of this committee just what you have to do anyway. You may vote for a dozen places here and this committee must select a place where we can be accommodated. None of the places that we vote for may have accommodations for this Association. We cannot then call you together to decide upon some other place of meeting, and it is left entirely in the hands of the committee to decide where we should go. That is the object we have in view in making the recommendation—that the time of the Association should not be taken up in instructing this committee to do something which on investigation they would find to be utterly impossible to do, and be obliged to decide for themselves after you had voted here where you would go.

MR. SETCHEL—I would like to ask if this motion includes the adoption of the committee's report?

THE PRESIDENT—It does not so state it. It says that the report be received.

MR. SETCHEL—Would an amendment be in order to receive and adopt?

THE PRESIDENT—I think so.

MR. SETCHEL—I move an amendment then—perhaps the mover will accept it—that the report of the committee be received and adopted.

MR. SPRAGUE—I accept the amendment.

The amendment was carried.

THE PRESIDENT—The next order of business is New Business.

TO INCORPORATE THE ASSOCIATION.

MR. SETCHEL—I have a little matter that I would like to bring under this head. I think there will be no objection to it when it will be understood.

CAPE MAY, June 16, 1891.

WHEREAS, The steady increase in membership and influence of the American Railway Master Mechanics' Association renders it necessary that it should be able to exercise a legal control over its finances, make and execute contracts and do all other acts that an Association of this kind may legally do to maintain and perpetuate its existence, now therefore be it

Resolved, That the Secretary and such other officers and members as may be required, are hereby authorized and directed to take the necessary steps to have this Association incorporated under the laws of the State of New York at the earliest practicable moment after the adjournment of this Convention and be-

fore any final action is taken in the disposition of the Boston Fund.

Mr. President, I move the adoption of the resolution.

MR. LAUDER—I second the motion. I do not think this is a matter that needs any discussion whatever.

THE PRESIDENT—You have heard the motion made by Mr. Setchel. The matter is open for discussion.

MR. SHAW—I was present at the formation of an organization in Washington that was of a national character, and this Association is also of a national character, and there is a provision under the United States laws whereby a charter can be obtained from the District of Columbia—I was so informed by a skilled attorney there—for the formation of a national organization. It would strike me, in view of the national character of this organization, that it would be proper to have it chartered in the District of Columbia.

MR. SETCHEL—I think that we will be fully able to transact all our business in any State in the Union if we are incorporated in the State of New York. I mentioned New York because the Secretary lives there and can attend to the matter immediately and it ought to be done at once. If the members recollect, at our Convention at Alexandria Bay, I had the honor to be your President, and I recommended that such action be taken, but it was not done. It ought to have been done long ago. We have no legal standing at all and we ought to be able to enforce any arrangement that we desire to make with anybody.

The resolution was adopted.

HONORARY MEMBERS.

SECRETARY SINCLAIR—I have new business to propose here in respect to new honorary members. The Association has on its list a certain number of honorary members composed of gentlemen who are mostly out of active service, and it is considered an honor, as the title implies, to be upon that list. We have a number of old members now. Some of them are railroad managers and railroad presidents, and others of them have retired from railroad service at a good old age, and I wish to propose eight new names for the honorary members' list. Most of the members will recognize the names as those of gentlemen who are well worthy of any honor that we can confer upon them. They are John Black, John F. Divine, E. T. Jeffery, Jacob Johann, Morris Sellers, J. Mulligan, F. L. Sheppard, and A. W. Sullivan.

I propose these gentlemen as honorary members.

MR. SPRAGUE—I would like to inquire if this is done with the consent of the parties whose names are mentioned?

SECRETARY SINCLAIR—It is with the consent of some of them. Of others I have not asked the consent.

MR. SPRAGUE—It seems to me that I would object to taking any such action with reference to a person who has not been consulted, For my part I should not care to be put on the honorary list before I had got through with active work, and it might be the same feeling with the others. I think we ought not to act in such cases without knowing their views in the matter.

MR. LAUDER—I do not think the objections that Mr. Sprague advances have really any weight. The placing of any member of this Association upon the honorary list confers upon him an honor of which any man must necessarily be proud. It does not curtail him in the slightest degree nor take away any of the power that he now possesses. It simply places him in an honorary position, and the dues that he now has to pay as an active member are remitted.

THE PRESIDENT—Will you let me just correct you there a moment? The honorary members are not entitled to vote. Section 5, of Article III of the Constitution says: "The dues of honorary members shall be remitted, and they shall have all the privileges of acting members excepting that of voting."

MR. LAUDER—Then I am mistaken. I thought that the only members who had not the privilege of voting were the Associate Members. That being the case I should be inclined to think, as Mr. Sprague says, that we ought to know the views of these men before we put them on the honorary list. It would be something like retiring a man. I should not care to be put on the honorary list as an honor and be deprived of my right to vote here.

THE PRESIDENT—If you will permit me, I think the point suggested by Mr. Sprague is well taken that the honorary members should be consulted before being placed on the list.

MR. SHAW—I do not see Mr. Johann in the room. I am satisfied that Mr. Johann is very proud of his active membership here, and I see his name mentioned there in the list for honorary membership.

SECRETARY SINCLAIR—As this objection has been raised, I will take off the names of those whom I have not consulted. That takes John Black and A. W. Sullivan from the list. The others I have consulted.

MR. FORNEY—I would like to ask who selected these names which are proposed for honorary membership?

THE PRESIDENT—I presume the Secretary has done so.

SECRETARY SINCLAIR—To answer Mr. Forney on that, I would say that I consulted with some of the older members and some of the members of the Executive Committee about the advisability of doing that, and they agreed with me that it would be right and proper.

MR. FORNEY—It seems to me that it is quite an honor to be elected an honorary member of this Association. It therefore seems to me that the honor ought to be conferred with a great deal of caution. Doubtless there are members here in the room who have in their minds different persons whom they would like to see on the list of honorary members. If we should allow each member of the Association to propose for honorary membership such

persons as he would like to see on that list we would soon swell the list to such a size that it would cease to be an honor to be an honorary member. I think that this matter should be considered very carefully and referred to the Executive Committee. I move that the whole matter be referred to the Executive Committee.

The motion was seconded.

THE PRESIDENT—That is not offered as an amendment to the motion, is it?

MR. FORNEY—I make it as an amendment to the motion.

THE PRESIDENT—The motion before the house is that the matter of placing members on the honorary list be referred to the Executive Committee—in this and all other cases?

MR. FORNEY—Yes, sir; in this and all other cases I will add. That disposition of it would leave any member free to propose any one for honorary membership if he saw proper and the case would then be maturely considered by the Executive Committee and presented here, and any hasty action would be avoided. If any man is free to propose any one for honorary membership, we will probably have at every annual meeting some one getting up and proposing some one for honorary membership. In all associations with which I have any connection, the list of honorary members is kept very small so that the honor may be one worthy of being received.

THE PRESIDENT—You are voting on the amendment that the whole matter be referred to the Executive Committee.

The amendment was carried.

THE PRESIDENT—Gentlemen, the noon hour has arrived, when, under the rules, subjects for discussion are in order.

SAFE HEAT FOR FLANGING STEEL.

SECRETARY SINCLAIR—I have only one subject handed in. If any other members wish to have other subjects discussed they can do so by handing me the names of the subjects, so that they can be announced. This subject is:

CAN STEEL BE FLANGED SAFELY AT OTHER THAN A RED HEAT?

It is proposed by Mr. Charles Blackwell, who will open the subject.

MR. BLACKWELL—The question is an important one, but we all so far realize the necessity of working steel at a *red heat*, that to do so is the rule of all our boiler shops. Nevertheless we may not all appreciate the danger we incur when we do not strictly adhere to this rule. To illustrate the danger, I would ask you to examine two samples of open-hearth steel now on exhibition in this place.

One end of each piece has been bent when *cold*, so that the total thickness

is just twice that of the single thickness. Close inspection fails to discover any signs of distress whatever. The central portion of each piece has been twisted when *red hot*, so as to resemble a corkscrew, and as might be expected, presents no indication of failure. The other end of each piece has been bent at a temperature of about 600 degrees, or that corresponding to a blue color on the surface from which the scale has been removed. Close inspection is not necessary to show that each piece is badly fractured at the centre of the bend; and in the case of the piece in which the grind-stone marks are parallel to its length, innumerable cracks, increasing in importance as the bend is approached, can readily be discovered by the naked eye, although much better by means of a magnifying glass. They can be traced from the point where the bending first commences, and fully demonstrate that at this temperature steel must not be bent in the slightest degree. This result impresses us with the wisdom of the recommendation of the American Boiler Makers' Association, when in session at Pittsburgh, in 1889, and to the effect that "flanging should be done at a *good red heat*, and not a single blow should be struck after the sheet has reached a temperature shown by *cherry-red* in *daylight*."

After the cherry-red has passed away, the black heat takes its place, and we cannot tell how rapidly the heat is passing off, and the temperature of greatest danger, above referred to, approaching. Cherry-red is the last visibly recognizable degree of heat before the metal becomes black, and is recommended by the American Boiler Makers' Association as the limit at which all work should be stopped. The samples on exhibition teach us that it is safer to cool off the sheet and finish the job cold rather than continue working at unknown temperatures.

Iron as well as steel is subject to this dangerous condition at about 600 degrees, and I believe all metals and alloys are similarly affected at temperatures peculiar to each case.

This matter was brought before the public some two or three years ago, but the good seed sown seems not to have taken as deep root as its importance deserves; and the thanks I have received from many Master Mechanics, whose minds I refreshed by showing them a piece of steel similar to those now in this hall, have indicated that my work has been appreciated, and received in the same spirit that prompted me to undertake it.

If we all follow the recommendations of the American Boiler Makers' Association as outlined above, and cease working steel when the limiting color of cherry-red by daylight has been reached, failures while flanging will be reduced to a minimum and our impressions that the steel manufacturer is largely responsible for such failures, will be proven to have been without foundation.

Mr. Shaw—I have seen the exhibit shown by Mr. Blackwell. I think it is a most wonderful example. I have been operating in steel myself for thirty odd years and I have encountered metal under that condition, and not homogeneous plate as this is declared to be. I would not have believed that homo-

geneous plates would behave in this manner, but this is declared to be homogeneous. The centre is twisted red hot. One end is bent cold, which shows the homogeneous character of the metal; while the other was bent at 600 degrees, or at the temperature which shows the blue. Some of the markings I have no doubt you can see clear across the room. I myself have condemned metal as being cold short that behaved in this manner, and I see in looking backwards how many errors I may have committed. I shows how we can go on and think we know all about it, and some little feature crops out like this which shows that we were wrong. I regard it as being as important a matter as could be brought before this body.

MR. LAUDER—It has been known to me for several years that what has been said in regard to the working of steel at different temperatures is strictly true. All steels that I have ever made any experiments with are brittle at a temperature that will produce a blue color when brightened. I have tried many experiments with the best of Otis fire-box plate and found in every case, that although while cold it would double down and hammer down under a trip hammer without a sign even of distress; at the blue temperature it would break invariably. Now to bring this down to a practical point, it shows the necessity of our watching our boiler makers, to see that when they have a seam to close, they do not get a big piece of iron and heat it and lay it on the sheet to warm it up before closing the seam. They may warm it up to a dangerous temperature, and undoubtedly many times do so, and thereby crack flanges that otherwise would have closed without any trouble.

SECRETARY SINCLAIR—This subject deserves the greatest publicity that our Association can give it. It was before the Society of Mechanical Engineers some years ago, and one of the members gave his experience with the bending of sheets and the bending of bar steel at a blue heat, and showed how brittle it was. But it seemed that the results did not impress themselves on the mechanical world. It is one of the things that all boiler makers ought to have constantly before them, and yet that very important subject did not seem to go outside the meeting, so far as public notice was concerned. On account of its importance I was anxious that Mr. Blackwell should ventilate it at this meeting, and I think the members should do their best to put it before the foremen boiler makers.

MR. SHAW—On planers and lathes where there is an effort to run at maximum speed, we have here an explanation why our tools break down so rapidly when they commence to heat, because they reach the blue temperature.

MR. PULASKI LEEDS, Louisville & Nashville—I am rather inclined to think that will not hold good in all cases. In all cutlery works the thin plate is hardened to its extreme point of hardness, and then the plate is straightened at this same blue temperature. A thin piece of carbon steel will stand a very severe blow of the hammer when under a tension or bending strain, to make it straight. In fact a piece of steel can be worked and straightened, that is so

hard while the temper is running that if you cool it off at the same point and strike it a blow it will fly like glass. I had experience with that in putting in an old Bristol valve, so that I do not think that it will hold good in high carbon steel when the temper is running.

Still I believe there is a danger point in heated steel, and I have not advocated the use of steel in axles for the very reason that they do quite often get to this blue temperature, or very nearly to it—sometimes go past it, as we have very often seen. They quite often reach the blue temperature where the least vibration of the steel will produce a flaw, and for that reason I have been very careful about advocating steel crank pins or steel axles, or even car axles. I have seen for a great many years steel used in those parts. I have seen a great many crank pins and steel axles break, and almost invariably you will find a fine flaw, perhaps the size of a half section of a silver half dollar, that is apparently old, the rest of the entire axle is bright, clear, fine grained steel, and it has always been my opinion that those flaws were produced at the time when they had reached the dangerous temperature, caused by a hot journal, or something of that kind. Now, I think that we will all acknowledge that the mere matter of its coming to a blue temperature has no effect upon it at all, unless there is some vibration. At the same time it takes but a very slight vibration to produce a flaw in steel that finally produces fatal results, so far as the part is concerned. I have talked about this thing with steel manufacturers for a good many years. I am perfectly convinced that it is the principal danger in steel.

I would like to hear from some one whether they think there is any danger of a zone or line forming at a certain distance from where we are flanging on a sheet—whether that has ever had any influence in cracking our side sheets and flue sheets of apparently first-class steel—whether we get enough vibrations at the distance from the red heat on our sheet where the blue line is formed between that and the cool sheet, and whether fractures have not been caused by that and really have condemned a great many steel fire-boxes?

Mr. Shaw—I do not think much can be said on this subject. In Mr. Leeds' observations he omitted to state that the same declaration is made in regard to iron. In fact, homogeneous plate is only superior iron after all. If it is a fact that there is a definite degree at which this destructive effect occurs, it must be, as Mr. Leeds suggests, at this blue line.

Mr. A. J. Cromwell, Baltimore & Ohio—In the treating of tool steel, I think a great many times steel is very seriously injured by heating—I refer now to square steel—by the smith not using proper care, the extreme corners get burned before the interior gets heated up. I think this should be looked after in all tool shops. That is, the smiths should be instructed to gradually heat the steel, so that the corners should not become too much heated before the interior gets heated. In our experience, brands of steel have been con-

demned as not standing and performing their proper work, when further investigation proved that it was due to the method of treatment.

THE CHAIRMAN (Mr. Hickey)—For the information of the Convention I would like to ask Mr. Blackwell if he found any difference in the experiments in proportion to the amount of carbon in the steel; whether the steel would not form the seam at high and low carbon, and whether it would do the same if the skin or outside surface was left on it. I believe that you said, Mr. Blackwell, that by filing off you could observe this process better. Now, the question is whether it would not make some difference if the skin or outer surface was left on?

MR. BLACKWELL—I believe no difference at all. The only difference is that if you leave the skin on you don't know when you get the 600 temperature, and you have got to remove a portion of the steel so as to be able to observe the colors as they come and go. If you remove the skin off one portion of the sample and leave the scale on the other, the fractures will run right across and underneath the scale. As regards the variation of carbon, my opinion is it cuts no figure in the case. The result is the same.

MR. LAUDER—I think that if there are any facts that we can bring out in regard to this subject they ought to be brought out. I cannot conceive of a more important subject than this is, if we can obtain facts in regard to it. Now these samples here show the facts. I have made a great many experiments with so-called low grade boiler plate, low in carbon, and always found precisely the same results that are exhibited here in these samples. This is with the ordinary steel. Now I would like to ask if there is any one present who has ever tried any of these experiments with basic steel? Possibly it is the slight amount of carbon in the steel that makes it act in this way. If there is any one here, any member who knows anything about basic steel and its behavior under the like conditions, I should be glad to hear from him.

MR. SHAW—I want to make this observation in reference to Mr. Lauder's remarks: The only difference between the two characters of steel would be the possible total absence of phosphorus in the basic steel. I must say that in my own experience in handling steel for thirty years—I introduced the homogeneous plate in the United States—I must plead ignorance of this fact that the metal would break at that temperature, but I do not believe from other experience that I have had that it would make any difference in regard to basic steel, because it means simply total absence of phosphorus.

MR. WM. H. LEWIS, Chicago, Burlington & Northern—I may be a little premature, but I think that perhaps this subject might be a good subject to refer to the Committee on Laboratory Tests. if that Committee is continued another year, which it probably will be. And that Committee in the meantime might continue their experiments with the different brands of steel that are now in the market, of the various degrees of carbon and at various tem-

peratures, and might be able to gather some very important information on the subject for the next year's meeting.

MR. JAMES MEEHAN, Cincinnati, New Orleans & Texas Pacific—I saw some specimens of basic steel tried under all circumstances and all temperatures, and showing no fracture. I am inclined to think that the phosphorus is so thoroughly eliminated in the basic steel, that the basic steel will not be subject to the defects under the different circumstances that the carbon steel is. I have taken a piece of basic steel that was very low in phosphorus, doubled it together and welded it. It was two inches wide and $\frac{5}{8}$ inch thick. There was a 3 inch hole punched through it and increased by a drift until it got out to 4 inches, which reduced the metal on one side to $\frac{3}{16}$ of an inch and on the other to $\frac{5}{16}$, without showing a particle of fracture. I have been very prejudiced against steel for crank pins and other positions in locomotive frames on account of its disposition to crystallize. On several occasions we took the crank pins from the engine because they were breaking, and after drawing them from the wheel we submitted them to a microscopic test to see if we couldn't detect the fracture, but it was not possible to do so. We put it under a hammer; broke the crank pin and found the fracture almost as perfect as if the crank pin was put between the centres of a lathe and a tool run in—nothing holding it but two inches in the centre. We then took out all our steel crank pins. I imputed it to the steel being high in phosphorus. I think the steel people who are practicing the basic process are making efforts to get over these defects. I have an idea that we will not suffer from any trouble of this kind in the future. I have now put in a set of basic steel crank pins and put on two sets of basic steel rods, and in all probability by this time next year we will be able to make some report, or at any rate within a few years from now. I am convinced that the basic steel is not similar to this in its nature, and that it will not be brittle at any particular temperature.

MR. GEORGE GIBBS, Chicago, Milwaukee & St. Paul—I haven't, unfortunately, heard the whole of this discussion, but I understand that the critical heat of the steel is under investigation. As regards phosphorus, I have analyzed many samples of boiler plate made by the "acid" process—that is to say, the ordinary process employed in this country—and plates from different makers will vary considerably in phosphorus—more considerably than would be the case between the best of that plate and the "basic" plate. The lowest phosphorus will run down to, say, .01 of 1 per cent.; the highest to probably .07, and the same effect of brittleness at this critical temperature is noticed. In fact, it seems to be a phenomenon inseparably connected with both iron and steel in all grades, as it is noticed also in iron to some extent. As the basic process is only employed to make available ores which are too high in phosphorus for the acid, the final product from either does not practically differ, and I cannot see why we should expect the physical property mentioned to be absent from basic steel.

Discussion closed.

MR. C. F. THOMAS then read the following report on:

EXHAUST PIPES, NOZZLES AND STEAM PASSAGES.

At the Old Point meeting your Committee reported, in substance, that the establishment of definite proportions of exhaust pipes relative to other parts of the locomotive was an impossibility, owing to the fact that so many variables would have to be taken into consideration; that no formula which we were acquainted with or could devise would meet the conditions.

This being the case, we can but suggest certain relations between different dimensions of the pipes, without regard to any one dimension of the engine, leaving to users the choice of size of pipe which will best suit local conditions.

We hold that the aim of the designers should be:

1st. To choose such size and shape as to secure free steaming.

2d. The exit of the steam should be as free as possible to avoid injurious back pressure.

3d. The discharge should be as nearly central with stack as can be, so as to produce maximum effect.

4th. Exhaust from one cylinder should not blow over into the other.

5th. The exhaust pipe should terminate at such distance from base of stack as to insure the latter being completely filled at each discharge.

It has unfortunately happened that the roads with which members of your Committee have been connected use single pipes almost exclusively, and we consider that the conditions as above laid down are best fulfilled by that pattern, still we are familiar with the results obtained with double nozzles.

In designing single pipes we hold that the most vital point is the relative areas at tip and at combining point. Where the last mentioned point is largely in excess of the other, it will inevitably result in blowing over the bridge, raising the back-pressure line into the well-known hump.

On the other hand, where the area at tip is the larger, it will be found that the velocity given to the steam at the bridge will, provided the form is easy, carry it past the tip without any ten-

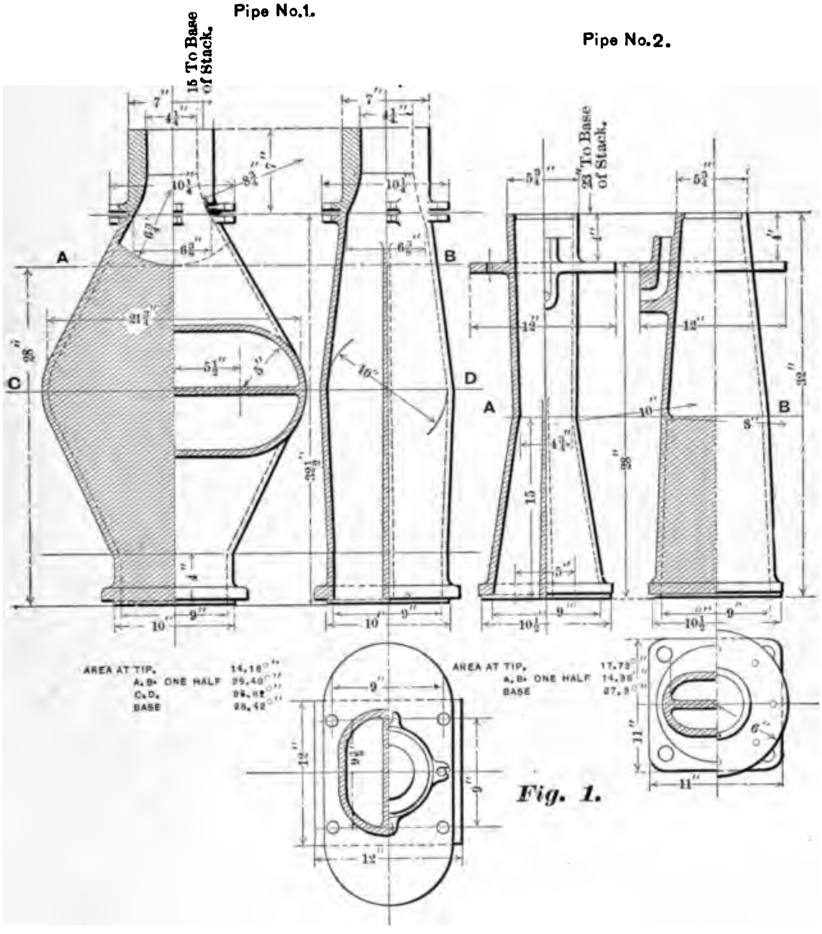


Fig. 1.

dency to blow over. Not only is this so, but the contrary effect will be at times observed—*i. e.*, there will be a partial rarefaction in opposite cylinder, as will be shown in indicator cards.

It has been clearly shown that the height of the bridge cuts no figure in effecting back pressure, but that lowering the bridge affords the designer a chance to straighten the discharge before it leaves the pipe.

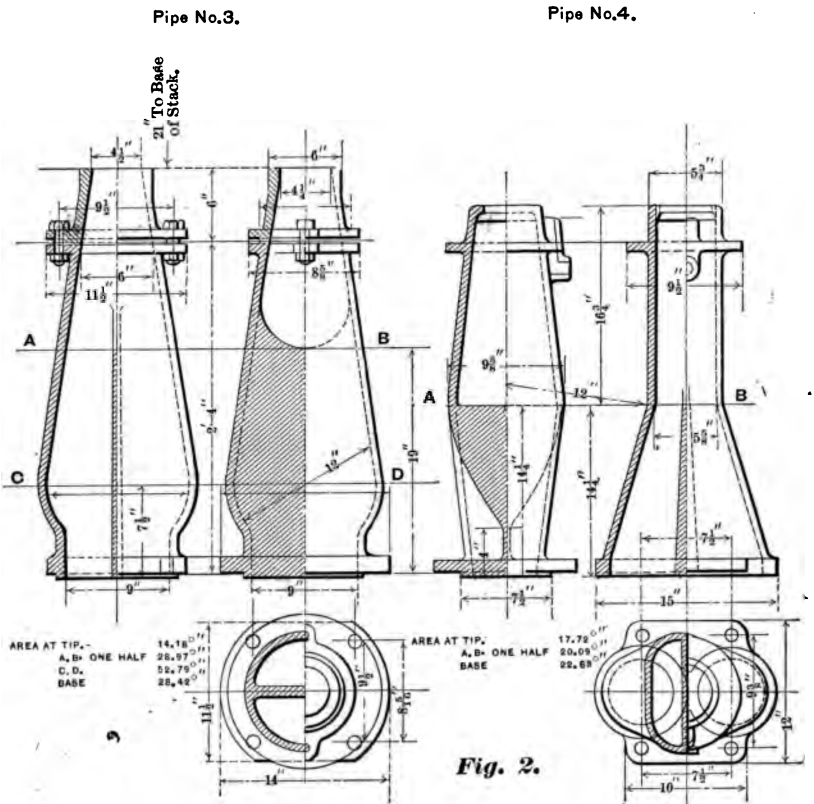


Fig. 2.

We suggest that the distance be made from 3 to 4½ times diameter of tip. Also that sudden changes in form be as far as possible avoided, both from the increased resistance to free exit, and also because the eddy caused by sudden enlargement or contraction, causes deposit of gas carbon from cylinder oil at those points.

We do not think that the pipe should be regarded as a reservoir, because such treatment so prolongs the discharge of the steam that the pressure is not relieved when the piston begins the return stroke.

We consider that the pre-release affords ample time to discharge the steam. The height of the pipe should be such as to

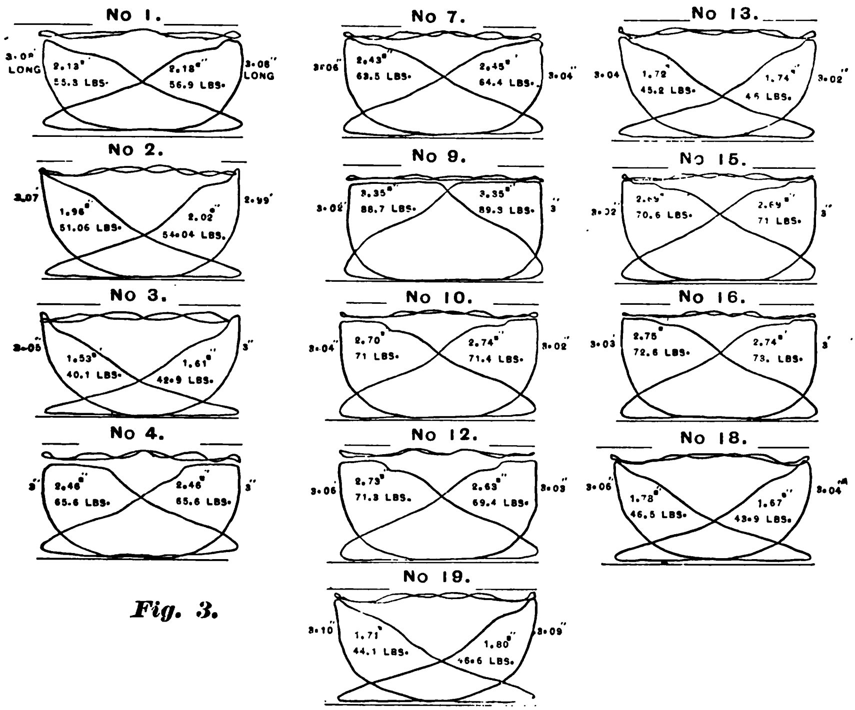


Fig. 3.

insure that the base of stack shall be completely filled at narrowest part. If, however, it be more than filled, an injurious eddy is formed.

We think that the general practice is to put the pipe too high. Where care is not taken to insure straight discharge, part of it impinges against side of stack with injurious results to steam-

ing. Raising the pipe, of course, obviates this trouble in a measure.

In trials made some years ago with a telescopic pipe it was found that tip could with benefit to steaming be lowered nearly to centre line of boiler, and your Committee is of the opinion that where a pipe is of such shape as to insure central and solid

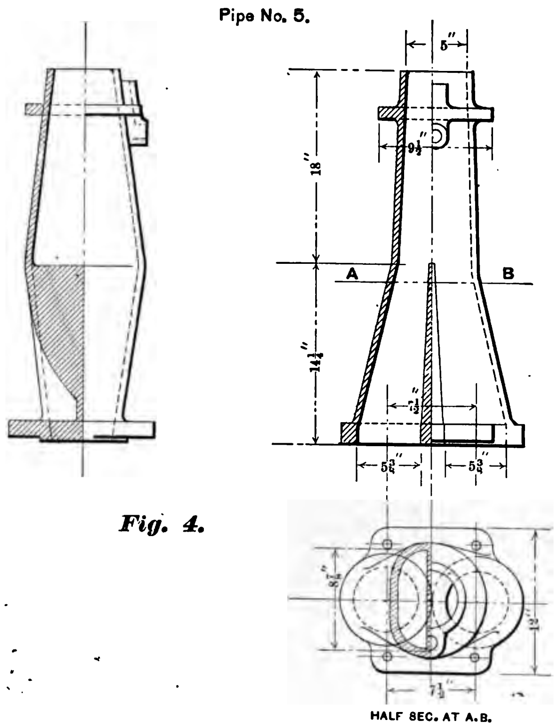


Fig. 4.

discharge the best results will be had with tip from 20 to 25 inches from base of stack.

There is reason to believe that the exhaust entrains a considerable quantity of smoke-stack gases before reaching the base of stack, and where circumstances require a very short smoke-stack, we strongly urge lowering the tip of pipe.

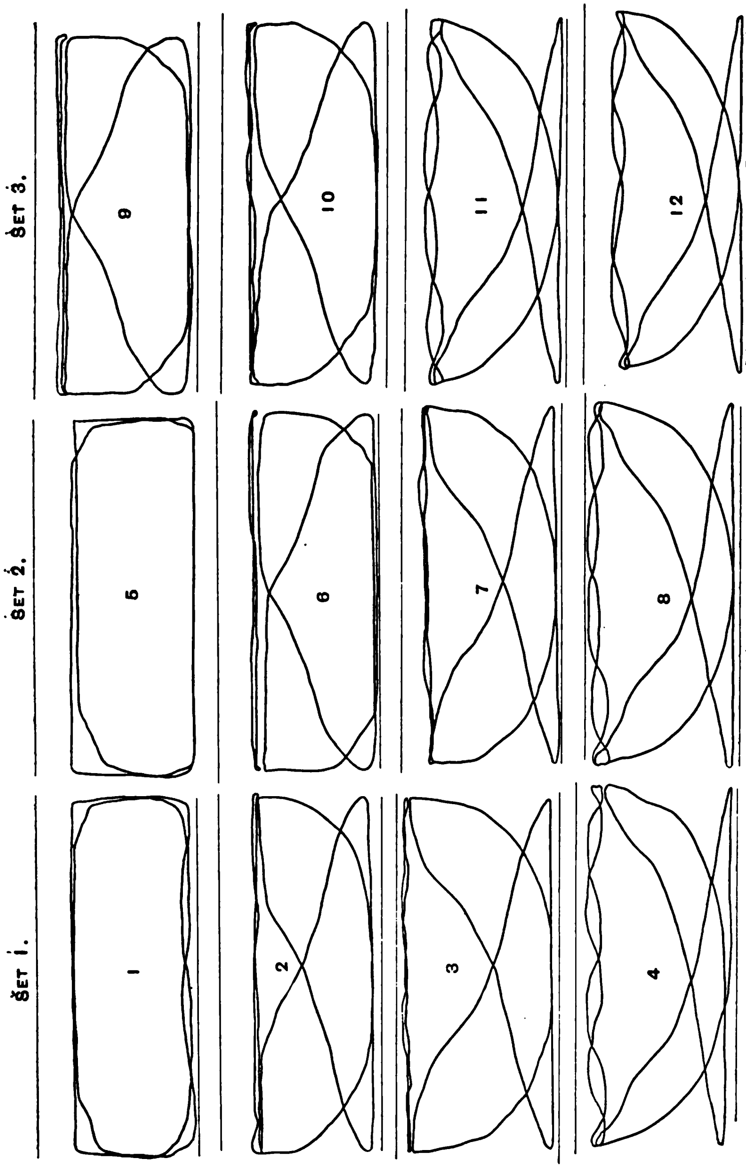
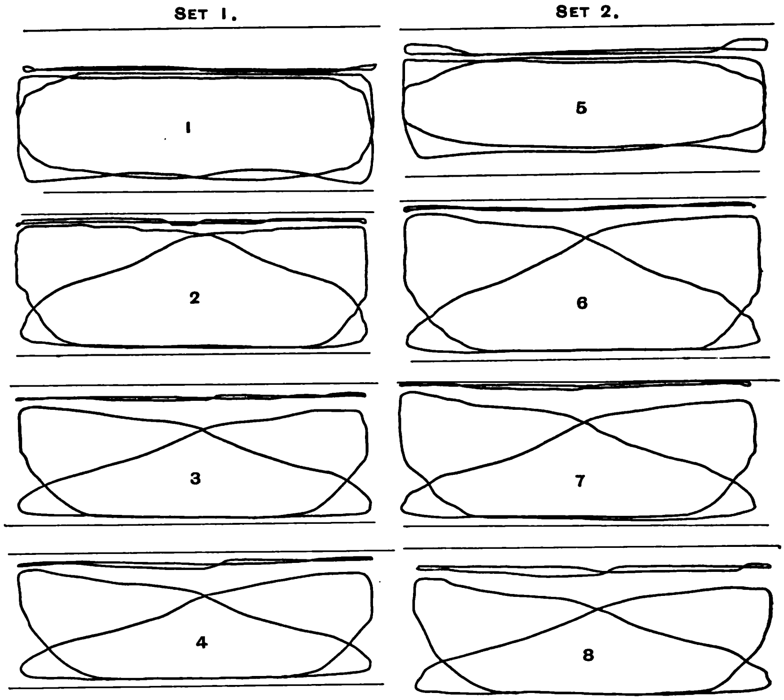


Fig. 5.

The Committee has experimented with the petticoat pipe, and derived no benefit from its use, except where the exhaust was inclined to cross over. We think that this is remedying a defect which should not exist.

As proof of the correctness of these conclusions we submit set of cards taken by Mr. Meehan, of the C., N. O. & T. P. Ry.

Fig. 6.



(Figs. 5 and 6), who kindly offered to test pipe designed by Committee against others of different forms. We also submit some cards taken by a member of the Committee together with print of pipe used (Figs. 3 and 4).

The engine tested by Mr. Meehan was an 18x24 Baldwin pas-

senger engine with 68-inch drivers. The pipes Nos. 1, 2 and 3 were in succession tested on this engine. Pipe No. 5 was tested on 17x22 passenger engine.

Pipe No. 2 is a development of that submitted at last meeting, but to test our theories we reduced area at bridge to 80% of tip area, and also reduced the height of bridge.

The reason for flattening the pipe was to straighten the discharge, and also to see whether an upward current could be induced in opposite cylinder.

It will be noticed that in Fig. 6, pipe No. 2 shows decidedly best results, and, as Mr. Meehan reports, gave decidedly best results in steaming.

When tried against pipe No. 3, on 20×24″ consolidation (Fig. 5) it shows conclusively that reduction at combining point has been carried too far. It will, however, be noticed that in none of the cards does pipe No. 2 show any tendency to blow over the bridge.

In explanation of these cards it should be stated that the vacuum shown is not to be implicitly relied upon, as the gauge was so sensitive as to be affected by motion of engine. The results can fairly be compared with one another.

In this connection attention should be called to the difficulty in determining the vacuum in smoke-box. The fluctuations in pressure are so rapid that no measuring device that we have seen will give more than a mean reading, which is not what is needed.

The only solution that we can suggest is to construct an indicator, which will transmit the action of vacuum on a diaphragm to the pencil motion of an indicator, so that smoke-box diagram can be taken on regular card. In this way only does it appear possible to settle the question raised by some members, which is: "Does not a very large and free exit of the steam exert most injurious result on the fire due to suddenness?"

In cards shown, vacuum is given in inches of mercury. Multiplying this by 13½, to give equivalent height of water column, gives such an excessive figure that we caution members against accepting them absolutely.

DIMENSIONS OF PIPE TESTED.

	No. 1.	No. 2.	No. 3.	No. 4.
Area at base	28.42	27.3	28.42	22.69
Area largest point	87.	27.3	52.79	22.69
Area top of bridge	29.4	14.38	28.97	20.09
Area at tip	14.18	17.72	14.18	19.63
Height of pipe	40 in.	32 in.	34 in.	31 in.
Height of bridge	28 in.	15 in.	19 in.	$14\frac{1}{4}$
Height of bridge to total height	.70	.47	.56	.46
Area at bridge to final area	2.07	.81	2.04	1.03

The cards taken with pipes Nos. 1, 2 and 3 are not strictly comparable, owing to differences in speed, throttle and cut off, but enough is shown to prove that the choking of pipe No. 2 is no detriment on the 18-inch engine.

TABLE 1.

DIAGRAMS FROM RICHMOND & DANVILLE LOCOMOTIVES.

No. 80 Scale.

Card No.	Boiler press.	Revs. per m.	Piston diam.	Piston stroke.	Piston area. □"	M. E. P.	I. H. P.	Cars in Train.	Notch.	Cut-off.		Throttle.
										F.S.	B.S.	
1	140	150	17	24	226.98	56.1	350.62	5	9	$7\frac{3}{16}$	$7\frac{1}{2}$	$\frac{1}{2}$
2	150	170	17	24	226.98	52.55	491.34	5	9	$7\frac{3}{16}$	$7\frac{1}{2}$	$\frac{1}{2}$
3	140	314	17	24	226.98	41.5	716.70	5	9	$7\frac{3}{16}$	$7\frac{1}{2}$	$\frac{1}{2}$
4	145	190	17	24	226.98	65.6	685.52	6	8	$10\frac{1}{8}$	$10\frac{3}{8}$	$\frac{3}{4}$
7	140	252	17	24	226.98	63.9	885.65	6	8	$10\frac{1}{8}$	$10\frac{3}{8}$	$\frac{1}{2}$
9	145	120	17	24	226.98	89.	587.4	6	8	$10\frac{1}{8}$	$10\frac{3}{8}$	$\frac{1}{2}$
10	145	136	17	24	226.98	71.2	532.57	6	8	$10\frac{1}{8}$	$10\frac{3}{8}$	$\frac{1}{2}$
12	145	154	17	24	226.98	70.3	588.41	6	9	$7\frac{3}{16}$	$7\frac{1}{2}$	$\frac{1}{2}$
13	150	214	17	24	226.68	45.6	536.	6	9	$7\frac{3}{16}$	$7\frac{1}{2}$	$\frac{1}{2}$
15	145	136	17	24	226.98	78.8	458.78	6	8	$10\frac{1}{8}$	$10\frac{3}{8}$	$\frac{1}{2}$
16	145	114	17	24	226 98	72.8	456.45	6	8	$10\frac{1}{8}$	$10\frac{3}{8}$	$\frac{1}{2}$
18	145	220	17	24	226.98	45.7	552.97	6	9	$7\frac{3}{16}$	$7\frac{1}{2}$	$\frac{1}{2}$
19	145	218	17	24	226.98	45.3	543.14	6	9	$7\frac{3}{16}$	$7\frac{1}{2}$	$\frac{1}{2}$

Area of exhaust pipe at junction, 20.28 □". Single tip: area, 19.63 □"

On the consolidation it is probable that both the tip and combining point areas could be enlarged with advantage. Still it

should be noted that cards 1, 2, 3 and 4, taken with pipe No. 3 (Fig. 6), are taken with part throttle, while Nos. 5, 6, 7 and 8 are with full opening.

The size of stack has a very marked effect upon the steaming with any given nozzle. Reduction of stack diameter will generally permit of increased nozzle diameter.

TABLE 2.

CINCINNATI, NEW ORLEANS & TEXAS PACIFIC ENGINE NO. 580, WITH THREE SETS OF EXHAUST PIPES, ALL WITH SINGLE NOZZLES.

Card No.	Boiler pressure.	Quadrant notch.	Throttle opening.	Piston speed	Vacuum top of ex. pipe.	Average back pressure.
1	140 lbs.	9th.	7/16 in.	240 ft.	1 in.	9⅝ lbs.
2	140 lbs.	3d.	7/16 in.	912 ft.	1¼ in.	7 lbs.
3	140 lbs.	2d.	⅞ in.	576 ft.	½ in.	6 lbs.
4	140 lbs.	2d.	7/16 in.	960 ft.	1 in.	8¾ lbs.
5	140 lbs.	9th.	⅜ in.	120 ft.	¾ in.	3 lbs.
6	140 lbs.	4th.	7/16 in.	432 ft.	7/16 in.	3½ lbs.
7	140 lbs.	2d.	4/8 in.	662 ft.	1½ in.	2¾ lbs.
8	135 lbs.	2d.	7/16 in.	1,032 ft.	1¾ in.	6 lbs.
9	140 lbs.	4th.	9/16 in.	480 ft.	1¾ in.	4 lbs.
10	145 lbs.	4th.	4/8 in.	600 ft.	1¾ in.	10¼ lbs.
11	140 lbs.	2d.	⅜ in.	1,080 ft.	1¾ in.	4½ lbs.
12	140 lbs.	2d.	⅜ in.	960 ft.	1¼ in.	4½ lbs.

TABLE 3.

CINCINNATI, NEW ORLEANS & TEXAS PACIFIC ENGINE 567—INDICATOR DIAGRAMS, SCALE 80 LBS.

Card No.	Boiler pressure.	Quadrant notch.	Throttle opening.	Piston speed	Vacuum top of ex. pipe.	Average back pressure.
1	145	14th.	½ in.	408 ft.	1½ in.	13 lbs.
2	125	4th.	⅞ in	360 ft.	1⅛ in.	6¼ lbs.
3	125	4th.	⅝ in.	408 ft.	1 in.	7½ lbs.
4	120	4th.	⅝ in.	480 ft.	1¼ in.	6 lbs.
5	130	13th.	Wide.	528 ft.	2¼ in.	19¾ lbs.
6	142	4th.	Wide.	384 ft.	1 in.	7½ lbs.
7	125	4th.	Wide.	456 ft.	1½ in.	7 lbs.
8	140	3d.	Wide.	528 ft.	1¼ in.	9 lbs.

Cards 1 and 5 were taken for results of back pressure only, and were taken in full gear after the engine had attained speed. Both exhaust pipes have single nozzles.

The Committee has had considerable experience with both straight and taper form, and is of the opinion that the stack with double taper is decidedly the best, and owing to its shape, will not be subject to the same wear as the straight pattern, which, as all know, is generally cut through, near the upper part. Taper stacks made in spring of 1885 are still in service.

In conclusion, your Committee wishes to thank Mr. Meehan, who has assisted us materially in securing data which was otherwise out of our reach. He took trouble to hurry his tests in order that result could be available for this report. We are also indebted to Mr. J. D. Campbell, of the New York Central for information furnished.

C. F. THOMAS,
A. W. GIBBS.

DISCUSSION ON DRAFT APPLIANCES.

On motion the report was received.

MR. C. F. THOMAS, Richmond & Danville—I would state that since writing this report and sending this report to the Executive Committee, I took some cards on a 17x24 inch engine, with a choke nozzle which was about 87 per cent. smaller at the junction than at the tip. I then enlarged the nozzle with the same junction point till it was only about 75 per cent. of the tip, and showed a decided falling off in the back pressure of the engine, showing that the tip was the decisive point on the back pressure, provided the junction point was brought within the ratio of the cylinder steam ways, and I have since learned that Mr. Meehan has some other data in reference to the report.

Mr. Shaw spoke in favor of running with small nozzles on the hypothesis that the increased draft gave better combustion.

MR. LAUDER—In making a hasty examination of the blue prints, I noticed one thing that certainly was very interesting, and that was the reduction of back pressure caused by the opening of the exhaust tip, and when the exhaust tip was opened considerably beyond the size of the pipe at the junction—the combining point, as the Committee, I think, call it—it seemed to largely reduce the back pressure. I cannot quite comprehend why the opening of the tip beyond the size of other portions of the pipe should produce such a marked decrease in the back pressure, or, in other words, increase the ease with which the steam gets to the atmosphere, but those cards show that very plainly, so plainly that there can be no question but that such is the fact. Now I have heard for a great many years arguments brought up to show that contracting the nozzle decreases the draft. Without ever having gone into

careful experiments to determine that, my observation has always been exactly in the other direction. If I could get an engine to make steam and get draft enough with that engine with a tip a foot in diameter, I think I should go out to a foot.

There is one very interesting question in regard to exhaust pipes, that possibly somebody can give us some information on, as there is a wide difference between our practice—a large number still adhering to the double exhaust tip of about 3 to 3¼ inches in diameter, while others are substituting the single exhaust, with a diameter of from 4¼ to 5 inches, and some of them even larger than that. Now it never was made quite clear to me why you could run a larger diameter exhaust pipe where it is single than you could where it is double; but we know that if we use two 5 inch exhaust nozzles there will be very little steam got, while if you combine them both in one 5 inch tip you can make all the steam you want. People have said that where they both come out of the hole they follow each other so closely that they tend to keep up a continuous pull on the fire. My answer to that is, that it cannot be true, for where the engine is climbing a grade and making a mile an hour the same difference exists; your big single pipe will make steam, but your big double pipes will not. Now it seems to me that the only reason why in one case you can run a bigger one than you can in the other, is the fact that with the single pipe you have got a reservoir for every exhaust, and the tendency is to follow up the vacuum produced by the first blow of the exhaust and to slightly prolong the pull on the fire or in other words slightly prolong the vacuum produced by the first discharge or expulsion. If that is not the effect, I cannot see why we should not run with two 5 inch tips on the locomotive when we know we can run with one. This is a question that I have heard discussed a good deal. I do not know whether it is worth while to go into a discussion as to the relative merits of the double exhaust and the single exhaust, because it is largely a matter of practice, in my judgment. A bituminous coal burning locomotive with extension smoke-box must have, to work well, a single exhaust. That has been my observation and I have followed it closely.

THE PRESIDENT—We would like to hear from Mr. Cushing on the subject of exhaust.

MR. G. W. CUSHING—I do not know that I can give anything new to the Association in addition to what Mr. Lauder has stated on the subject. My experience has been much in the same direction. I am quite clear, however, in regard to the so-called single exhaust, that it is preferable to the double exhaust.

MR. GEORGE GIBBS—I haven't had time before this moment to read over the report, and collect the data that is referred to. I hope the Committee will be able to formulate some theory for the action of the exhaust of the locomotive in the stack. It seems to me that we should be clear on that point, if possible, in order to arrive at a formula for designing an exhaust nozzle. There

seems to be two possible ways, or a combination of two, in which an exhaust may act. One is by a piston action drawing the steam after it by the vacuums produced between the separate exhausts. The other is as a jet exhauster which pulls out the gas by friction and mixing with the jet itself. And the third is where you have a combination of these methods. We have studied over this subject a good deal and are completely at sea, I must say now, as to which way it acts, but it seems to be pretty clear to us on our road, that neither one of those will act alone, and that probably the jet action is the more important of the two. We had an engine there with a standard tip in and a single nozzle. The base of the stack was about 20 inches above the tip, and we put on an extension which raised that up to about ten inches. While in the standard arrangement it was a free steamer, the extension completely ruined the action of the exhaust. In neither case, I believe, did the jet fill the stack at the base. I believe, moreover, from experiments in looking in at the front end, that it very seldom does so; that the jet goes up much more like a cylinder than a cone, and our explanation of the failure of the second case was that the steam did not have enough surface to act on the gas—to pull it up the stack. I notice the Committee say here that where you decrease the diameter of the stack you will be able to increase the size of the nozzle. It would look to me as if in the first case the jet did not fill the stack at the base, it would still less do so in the second case, proving that it did not act as a piston, but more as a jet, and I would like to hear what the Committee have to say on that, if they can give us any theory on the action of the exhaust.

MR. THOMAS—The experiments on that have been more from actual test, and I suppose the proper way to get at anything of that kind would be from a photographic view of the jet, which is a very hard thing to get in the front end, but I expect, as Mr. Gibbs said, that we are diverging from a jet to a piston, and from the fluctuating waves—retaining power of the steam, in carrying out the stack, which proves to us by experiment that we can make these alterations and hold the steaming qualities of the engine. I cannot tell you positively as to that, as I haven't gone into experiments in regard to suction or vaccum in the stacks proper; that is, in the pipes in the side of the stacks, showing whether there is a piston action there or whether there is the jet action from the nozzle to the stack.

MR. L. R. POMEROY—I was very much interested in this subject in conversing with Mr. Wallis in connection with his experiments at Altoona. They experimented by photographing a jet of steam, and arranged the heights of the nozzle so that the expanding steam would strike fairly at the neck of the stack. If too low, it would strike below that point, and tend to spill or be deflected inside the box, and nullify the solid action of the steam and best effect of the vaccum. I would also say that their experience for a year past has almost been identical with that reported by the Committee, namely, that the area of the exhaust opening should be slightly less at the junction point than at the tip, conforming more nearly with the natural expansion of steam.

It seems very desirable that this subject should be continued for another year, for the reason that Mr. Wallis, and Mr. Marshall, Superintendent of motive power of the P. W. & B., have some further experiments in progress touching this matter. They have been going into this question at very great length, and there are data that might be obtained on this point from some German engineers who are working the matter up. It seems that an altogether different set of circumstances exists from a jet flowing continuously from a pipe and an intermittent blast, and the harmonizing of these two would tend to formulate such practice as would be available for use. That was my object in asking that this subject be continued with a view of drawing in these data and making them available.

MR. STEWART—I suppose that all master mechanics here have experimented more or less with exhaust pipes, and with smoke stacks. We, in the eastern country, have had a varied experience with these things. In the first place we have small boilers to contend with that we built years ago, and our officers expect us to get as much steam out of a small boiler as we do out of a large one. We try to do the best we can to accommodate them. Another thing that enters into this question is the quality of coal that we get. It makes some difference about the size of the exhaust pipe, with an engine steaming, whether we use Pocahontas coal, or Cumberland coal, or slack—something that has lain exposed to the air for one, two, or three years, or whether we get fresh mined coal. As regards the form and size of exhaust pipe and the smoke stack together, I haven't photographed any jets of steam, but commencing at the exhaust pipe, I have experimented with that for the last two years, increasing the size of the body of the exhaust pipe itself until now with an 18x24 inch engine, I use an exhaust pipe that is 11 inches in diameter on the inside. I use a single exhaust, extending the bridge in the exhaust pipe about 5 inches above the base of the saddle, carrying the pipe straight to within 5 inches of the top, and then bringing it in to receive the tip which is 6½ inches in diameter at the base, tapering gradually to the size which I wanted. I found by actual experiment that I got the freest running engine with that size of an exhaust. After determining that, then the question came, what size of a smoke-stack do you want to receive that blast? I was then using a 19-inch stack on a 20x24-inch engine, and an 18-inch stack on an 18x24-inch engine. I commenced with the 18-inch engine, reducing the size of the straight smoke-stack which we are using half an inch at a time, as an experiment, until I got the engine with a 15-inch smoke-stack, inside diameter. At that joint I found that we had a clear exhaust. The engine cleared itself nicely of smoke and gases. Upon that engine up to that time I was using a 4¼-inch tip. After having reduced the size of the smoke-stack to 15 inches, I gradually enlarged the exhaust tip until I got 4¾, which materially reduced the consumption of fuel and retained the steaming qualities of the engine at the same point. I then commenced with another engine—a 20x24-inch consolidation engine. I was using an exhaust pipe of which the tip was 18

inches below the base of the stack. The boiler was 56 inches diameter, the exhaust nozzle single and the exhaust pipe 11 inches below the stack. There was no place that I could make that engine steam without reducing the exhaust nozzle to 4 inches with an exhaust pipe 18 inches below the base of the stack. I then commenced to reduce the length of the exhaust pipe until I had 22 inches, the engine continuously doing better on steaming. I got down to 24 inches and then stopped, finding the best results with a 4¾-inch nozzle. Now I do not lay this down as a theory for anybody to follow. This is what I have found. I know there are a good many cranks on smoke-stacks and exhaust pipes, but this thing I have found in actual experience, that a smoke-stack 3 inches smaller than the barrel of the cylinder is a pretty good rule to follow.

MR. LEWIS—I would like to ask Mr. Stewart to explain how he arrived at the minimum reduction. He speaks of reducing the size of the stack by half inches until he reached 15 inches. Now, isn't it possible that he could have got down to 14 inches? What was it that indicated to him that 15 inches was the limit?

MR. STEWART—I didn't stop at 15 inches. I reduced it to 14 inches, but when I had gone below 15 inches, then I perceived that my engine was not working as well as it did at 15 inches. I reduced it to 14½ inches and then to 14 inches, and I did not obtain as good results at 14 inches as I did at 15. So I concluded I had reached the point where I could stop, at 15 inches, and returned to that size of stack.

MR. J. S. MCCRUM, Kansas City, Fort Scott & Gulf—I think this subject of exhaust pipes and nozzles is certainly a very interesting one. I would be in favor of continuing the committee on that subject for another year. My experiments have been somewhat similar to Mr. Stewart's. I have practically been using for a year and a half or two years a rather larger exhaust pipe, that is, a larger diameter of the body of the pipe than anything I have seen, and I have had the impression that there is merit in the principles of the expansion pipe; that is taking a large cavity for the steam to enter before it is discharged, and in all cases where I have used that pipe I have, I think, improved the working of my engines and made a soft, easy blast, burning less coal and getting good steaming engines. But, formerly, I am satisfied, I was running the pipe too high in the smoke-box. For the last two or three months I have been reducing the height of the pipe—the distance between the discharge and the base of the stack—with good results. I have no data to show what the results are, but so far as indications go, I seem to be getting better results by lowering the exhaust pipe. I was very much interested in the matter of the pipe No. 2, and I had made a pattern of that pipe which is an exact duplicate of that, by parting the pipe in the centre so that I could change the area of size there. I had the pipe at the top so that I could also vary that, and see what the results would be by varying the size of the discharge appropriate to the pipe at the top. I haven't any data on that, but am in hopes to have something later.

MR. J. Y. SMITH—For the last three years I have been experimenting almost continuously with exhaust pipes. The greatest enemy I have found in exhaust pipes is poor oil. I have detached some of the oil inside of the pipe by dropping in potash. The old wood-burning engine would seldom have any clogging up. Now, the action on that part of the pipe is when the engine is working, the steam doesn't burn onto the pipe; but the moment we shut off the steam the oil lodged on the pipe is turned into a carbon about as hard as iron. We do not, in my opinion, take enough pains with the exhaust. We have too much high grade and low grade oils, and thick and thin pipes, and getting them a little shorter. These gentlemen speak about large smoke-stacks and small ones, etc. One thing I did was to take and divide the steam openings in the exhaust pipes, and in order that the steam going out opposed by the fifteen pounds atmospheric pressure that it has to overcome, I charged the inside of the exhaust pipe with columns of heated air, giving more life to the steam, and the discharge nozzles are about 9½ inches in diameter. I have turned the exhaust pipe bottom side up, and we are meeting with good success in steaming and increasing the power of every locomotive we have put them on.

MR. G. W. WEST, New York, Ontario & Western—I have experimented a little on exhaust pipes, but the results of my experience are so radically different from what have already been given that I would feel hardly free to mention them. I have been working on a double exhaust for the past year, and on some engines that were built by Brooks for our company which never had steamed freely, I have been able to get decidedly better results with a better pipe. But in that connection I would say we found that by lowering the tip to three or four inches above the centre of the smoke-box, we got the very best results in the saving of fuel and in the steaming qualities of the engine. I think that the height of pipe has more to do with it than the single or double nozzle.

MR. WILLIAM MONTGOMERY, Central of New Jersey—The diameters of the stack and the exhaust pipe, it seems to me, are very important in relation to each other; and the effect of producing a rapid combustion of fuel is due, it seems to me, to the action of them both. That question was discussed very clearly in the *National Car and Locomotive Builder* about a year and a half ago by some master mechanic or expert. It seemed that the theory of a larger single nozzle being practicable is from the fact that it produces a current in the centre of the stack, and expels the air with greater force from the stack than a double nozzle, where the exhaust takes place only on one side, and for that reason a larger nozzle can be used where a single pipe is put in than where a double pipe is put in. I have seen two or three instances where the partition on the top of the double nozzle was taken out where an engine was using a nozzle 2⅞ inches. It was cut entirely out, and the steam was allowed to pass out of the two nozzles, and the result was that the engine steamed as well as she did with one nozzle, and the back pressure was very

much reduced, making a great improvement in the engine. Now it seems to me from observation that the theory of expanding the steam in the stack is the correct one in regard to the single nozzle. Before we applied the extension fronts, and were using low nozzles, we found sometimes at the top of the petticoat pipes which ran very near to the top of the arch, they were ground out, and if any of you ever noticed, standing on the front of the engine with the door open, that the steam spread as it went up, and continued to spread clear up into the stack, which was the reason that we got a better draft and a stronger draft with a lower nozzle than we did with a higher nozzle. In many cases it seems to me that where the double nozzle is used and contracted down by the engineers or those in charge of the engine to produce a rapid combustion of fuel, that it is contracted down so small that the force of the steam passes off into the atmosphere before it is expanded sufficiently to fill the stack, and the result is that a light vacuum is produced, which does not properly stimulate on the fire. The lower you can get the nozzle and the quicker we can spread the steam in the stack and fill it up, the better effect it will have on the fire. On reducing the stack we noticed that the stacks wore out always in the top; also, that in using the straight stack the lining wore out at the top. This I think is due to the steam expanding and spreading, and the smaller the stack we can use the better the draft.

MR. SHAW—In going down to the refinements of this matter, I think that the closer we follow the men who construct ejectors, the nearer we would get to it. When you talk of the piston stroke of the steam, take the high speed engine, you have 1,400 strokes a minute, which practically amounts to a continuous stream, and that takes definite angles. Those angles have been discovered by the men who make ejectors, and I find that they have got to that degree of perfection with the steam ejector to-day to produce a partial vacuum that is superior to any air pump that can be constructed. I have kept them at work for months and months maintaining a vacuum of 22 inches, where I had previously used air pumps, and I found this was superior to the air pumps. I hold that so far as the steam is concerned, the first duty is to get out the gases at as low a velocity as you can. That means a large diameter, in order to carry out the principles that have held in the ejector. It means, finally, a sub-division of the stack. I believe that the smoke arches will be made larger and the stacks made larger, and sub-divisions made in the stack in order to maintain the relations which exist in the ejector. You want a uniform velocity, and such velocity as will not pick up the coal. And the tendency to-day is to enlarge the areas. In the Wootten engine they have reached the maximum and larger areas all through the boilers, increasing also the smoke arch. It means you have got to burn so much air with your coal, and in burning the air you have got to get rid of it, and if you get rid of it on large areas you can carry shallow fire, get rid of your smoke, get better combustion, and it is not hard on the exhaust.

MR D. L. BARNES—In this report there is an item on the vacuum of smoke-boxes which I would like to have explained. On table 2, cards eight and nine, it states, with four and six pounds back pressure, there was 23½ inches vacuum of water. Now that is over three or four times the amount I have commonly seen with that amount of back pressure, and I would like to ask Mr. Meehan, if he is here, where the tip of the vacuum gauge was located in the smoke-box? That might make the difference.

SECRETARY SINCLAIR—There is a prominent railroad in this country that is using a standard stack. They say one size of stack is suitable for all sizes of engines and they put their theory into practice. I think it would be very desirable to have the opinions of the members of the Association on that practice.

MR. THOMAS—I will state in regard to vacuums that in taking those vacuums I noted a marked difference on comparatively the same cards in the working of that engine with the variation of the fire on the grates or openings in the fire-box. Probably that accounts for some of the differences in the vacuums that Mr. Barnes speaks of.

MR. GIBBS—It looks to me possible to draw some conclusion from the inches of vacuum that are given in different engines, burning different coal, under different conditions. You would not be able to keep a pound of coal on the grate with the vacuums given in these tables on page 7. They vary from all the way from 13 to 25 or 36 inches, whereas five or six inches of water is all we can use to keep our thin fire on the grate. With the Western coal we have to use a thin fire.

SECRETARY SINCLAIR—In the report it is mentioned that the vacuums were taken with mercury and then calculations made from that. I think they are very liable to fall into error that way. I have experimented very considerably with the vacuum for the smoke-stacks, with inches of water, and I never got more than 8 inches when the engine was working at its very hardest, and it is very rarely above six. With a fairly hard-working engine the vacuum was from 3 to 5 inches. I think there is a mistake made in the calculation and that it doesn't represent the truth at all.

MR. BARNES—I have just finished an experiment with a heavy engine where we had 16 inches vacuum of water, and the experiments were repeated so many times that there cannot be any question about it. But in these experiments the vacuum gauge was just extended inside the arch. We had to carry about 24 inches of fire to get that vacuum and keep the coal on the grates. Any reduction of the thickness of the fire caused the fire to leave a decreased vacuum.

MR. STEWART—I move that the discussion on this subject be closed.

MR. MONTGOMERY—I move that the Committee be continued and the question left open another year.

Mr. Montgomery's motion was carried.

THE PRESIDENT—The Secretary reports that the report of the Committee on Testing Laboratories is on the table, and he asks time to get it printed. The next subject will be the advantages or disadvantages of placing the fire-box above the frame.

SECRETARY SINCLAIR—A somewhat lengthy report was submitted last year and the members of the Association did not consider it was sufficiently conclusive, and a motion was carried to continue the committee. Mr. Griffiths, who has been carrying on the work, writes as follows:

ADVANTAGES OR DISADVANTAGES OF PLACING FIRE-BOXES ABOVE FRAMES.

When last year's report of wide fire-boxes was presented the Committee, thinking they might be able to procure figures relative to the economy in fuel, asked for an extension of time for their report. I have taken this subject up again, and have written a large number of personal letters, but have been unable to get the desired information. I therefore desire to have the report closed as made last year, and placed before the Convention for the information sought.

F. B. GRIFFITHS.

THE PRESIDENT—The next subject is "The Relative Value of Steel and Iron Axles."

The Secretary read the following report from the Committee on the Relative Value of Steel and Iron Axles:

RELATIVE VALUE OF STEEL AND IRON AXLES.

Your Committee appointed to Investigate the Relative Value of Steel and Iron Axles issued a circular designed, *First*, to ascertain particulars about the breakage of axles and the character of the axles that broke; *Second*, to find out about the relative wear of steel and iron axles between turnings. The members did not display much interest in this question, for only twenty-five answers were received to the circulars, and the replies did not throw much light on the question under investigation. Ten of the roads heard from were using iron axles exclusively, six were using principally iron, two expressed a preference for iron, and four preferred steel axles.

The information obtained respecting the breakage of axles was not of a kind that safe deductions could be made from. Iron axles and different kinds of steel axles broke. In some cases the journal wear was very great; in others the wear was small. Except in the letter from Mr. I. N. Ely, of the Pennsylvania Railroad, published below, there were no facts given by those who sent in replies to show any special cause for axles breaking.

There is a conflict of opinion among our members as to the relative value of iron and steel for durability between turnings. Several of them say that steel gives the better service, while others say that iron wears better than steel. A case is mentioned by Mr. A. T. Hatswell, where iron axles have run between 200,000 and 300,000 miles without turning, and that they still calliper perfectly true with a reduction in diameter of about $\frac{1}{32}$ inch. On the other hand, Mr. E. B. Wall voices the experience of several large roads by saying that steel axles give the greater service between turnings. But he could not give any comparative mileage of iron and steel axles, for the reason that they do not have axles made of the different material running under the same engine. Unless this is done a comparison is worthless.

Concerning the subject under investigation, Mr. T. N. Ely, of the Pennsylvania Railroad, writes: "There are on hand no data which give the comparative life between iron and steel driving axles.

"Until within the last two years iron driving axles were used exclusively in freight service, and steel driving axles exclusively in passenger service. Lately, however, we have changed the practice, so far as main driving axles in freight service are concerned, changing the material from iron to steel, but retaining the same sizes as were formerly used.

"In former years it was the practice when making the key-way for the driving wheel to drill with a center drill two or three holes near the inner end of the wheel-fit on the axle, chip out the metal standing between them, and plane the key-way.

"This practice, especially in the case of steel axles, was a source of great trouble, because the reduction of diameter, slight

as it was, at the inner end of the key-way caused the steel axles to break, and like all steel axles they broke in detail. This was altogether due to the pressure upon the piston.

"It is readily seen that this assertion is correct, when it is remembered that the key-ways in the wheel and axle are always in tension, whether the piston be at the forward end of the stroke or at the back end. This method of making the key-ways was abandoned and a milling machine made use of, so that the bottom of the key-way gradually rises at the inner end of the wheel-fit, and since this change was made no further breakages of this nature have occurred.

"One very striking thing observed in the breakage of the steel driving axles was this: The center drill was made with the usual small teat, which, of course, left in the center of the bottom of the hole a small cavity, and the fracture of the axle was invariably through this small cavity, clearly illustrating one of the peculiarities of steel, viz.: that, when breaking, the fracture will invariably occur directly through the smallest section, and it is quite different in this respect from wrought-iron axles made of scrap, for in the case of the latter the fracture was just as frequently at some other place as through the small cavity. Since this fault of construction has been changed no further fractures have occurred at the point mentioned, and such fractures were always confined to the main driving axles. The other point at which fractures occurred occasionally is in the reduced portion of the axle between the journals. Sometimes it occurs through the key-way for the eccentrics and sometimes nearer the center, where the axle is still further reduced, but breakages of this kind are again only found on the main driving axles.

"There is no record extant of any of the other driving axles ever having broken, except in the case of the one class of engines, where the last axle is under the fire-box, and then only in cases where the ash pan has become defective by inattention and the covering over the axle has warped out of shape to such an extent as to cut a groove in the axle.

"From this it will be observed that driving axles very rarely break in the journal, or even in the wheel-fit, and, as a conse-

quence, the diameter of the fracture is that of the original diameter of the axle. The cause of this is mainly that by a fixed limit for wear, instead of a mileage limit, the axles are removed before the danger point is reached.

"Engine-truck axles are made of steel and hammered scrap iron. Steel axles are used in the passenger service and iron axles in the freight service. A breakage of either is exceedingly rare, principally on account of the limit in journal diameter, which removes them out of service before the danger point is reached.

"All sizes of axles have broken under cars. We cannot say, however, that steel has been worse or better in this respect than iron. There have been cases of the large size of axles breaking in the journal, and in some cases even at the center of the journal. The cases, however, are not very common, so long as the rules for journal limits are properly observed. A few axles have, however, broken between the wheels in the reduced portion. The cause, however, was mainly incorrect shape. As now made, the only danger point is the inner end of the journal, and breakages at this point are guarded against by the rules for journal limit.

"Steel driving axles and steel engine-truck axles are made from open-hearth steel.

"Steel tender-truck axles are now used for all classes of new engines, and are made from open-hearth or Bessemer steel.

"All car axles now used, whether for passenger or for freight service, are made of steel. In passenger service the material is made by the open-hearth process. In the freight service both open-hearth and Bessemer steel is used.

"Iron driving-wheel axles and iron locomotive-truck axles are made from hammered scrap.

"In the second question the point is raised as to the relative service obtained from iron and steel axles between turnings. For the reasons already given no data are obtainable."

In conclusion, your Committee is unable to recommend any standards, owing to the limited number of replies received in which any recommendation is made, and we, therefore, submit

it to the Convention that the members present may think it up and come to a conclusion.

The following are some particulars of the information furnished respecting axles:

TABLE 1

ILLUSTRATES DIFFERENCE IN MILEAGE OF DRIVING AXLE JOURNALS PER $\frac{1}{64}$ INCH WEAR.

Road.	Amt. of Wear.	Steel Axles.	Iron Axles.
F. & P. M.	$\frac{16}{64}$"	31,888 miles.	......
F. & P. M.	$\frac{4}{64}$"	25,002 miles.	......
Pennsylvania Lines	$\frac{32}{64}$"	......	6,250 miles.
Pennsylvania Lines	$\frac{9}{64}$"	26,585 miles.	......
Lehigh Valley	$\frac{1}{64}$"	234,274 miles.	......

TABLE 2.

DRIVING AXLES.

Road.	Service.	Standard size of journal.		Limit of wear of journal.		Mileage limit.	Weight per journal.
		Steel.	Iron.	Steel.	Iron.		
Union Pacific	Pass.	8 in.	......	7½ in.	......	450,000	16,000 lbs.
Louis. & Nash.	Pass.	......	7½ in.	......	7 in.	300,000	16,000 lbs.
Prov. & Spring.	Pass.	......	7 in.	......	6¾ in.	......	12,000 lbs.
D., L. & W.	Pass.	6½ in.	......	6 in.	......	......	12,000 lbs.
D., L. & W.	Pass.	7 in.	......	6½ in.	......	......	16,000 lbs.
D., L. & W.	Pass.	8 in.	......	7½ in.	......	......	20,000 lbs.
D., L. & W.	Pass.	......	6½ in.	......	6 in.	......	12,000 lbs.
D., L. & W.	Pass.	......	7 in.	......	6½ in.	......	16,000 lbs.
D., L. & W.	Pass.	......	8 in.	......	7½ in.	......	20,000 lbs.
Union Pacific	Freight.	8 in.	......	7½ in.	......	600,000	16,000 lbs.
Louis. & Nash.	Freight.	......	7¾ in.	......	......	......	14,000 lbs.
D., L. & W.	Freight.	6½ in.	......	6 in.	......	......	12,000 lbs.
D., L. & W.	Freight.	7 in.	......	6½ in.	......	......	16,000 lbs.
D., L. & W.	Freight.	7½ in.	......	7 in.	......	......	20,000 lbs.

TABLE 3.

Engine Truck Axles in Passenger Service.

Road.	Standard size dia. jour.		Limit of wear dia. jour.		Mileage Limit.	Weight per journal
	Steel.	Iron.	Steel.	Iron.		
Union Pacific	------	5 in.	------	4¾ in.	250,000	8,000 lbs.
Louisville & Nashville	------	4¾ in.	------	------	--------	7,000 lbs.
Providence & Springfield	------	4½ in.	------	4¼ in.	--------	7,000 lbs.
D., L. & W.	4½ in.	------	4¼ in.	------	--------	5,000 lbs.
D., L. & W.	5 in.	------	4¾ in.	------	--------	8,000 lbs.
D., L. & W.	5½ in.	------	5⅛ in.	------	--------	11,000 lbs.
D., L. & W.	------	4½ in.	------	4¼ in.	--------	5,000 lbs.
D., L. & W.	------	5 in.	------	4¾ in.	--------	8,000 lbs.
D., L. & W.	------	5½ in.	------	5⅛ in.	--------	11,000 lbs.

TABLE 4.

Engine Truck Axles in Freight Service.

Road.	Standard size dia. jour.		Limit of wear dia. jour.		Mileage limit.	Weight per journal.
	Steel.	Iron.	Steel.	Iron.		
Union Pacific	------	5½ in.	------	5$\frac{3}{16}$ in.	250,000	5,000 lbs.
Louisville & Nashville	------	5 in.	------	------	--------	8,500 lbs.
Providence & Spring.	------	4½ in.	------	4¼ in.	--------	7,000 lbs.
D., L. & W.	5 in.	------	4¾ in.	------	--------	5,000 to 11,000 lbs.
D., L. & W.	------	5 in.	------	------	--------	5,000 to 11,000 lbs.

TABLE 5.

TENDER AND CAR AXLES.

Road.	Standard size dia. jour. Steel.	Standard size dia. jour. Iron.	Limit of wear dia. jour. Steel.	Limit of wear dia. jour. Iron.	Mileage limit.	Capacity of car.
Union Pacific	------	4¼ in.	------	4 in.	250,000	60,000 lbs.
Union Pacific	------	4¼ in	------	3⅞ in.	250,000	60,000 lbs.
Louisville & Nashville	------	4 in.	------	------	--------	----------------
Pennsylvania Lines	4 in.	------	3½ in.	------	--------	60,000 lbs.
Mason City & Ft. D.	------	3¾ in	------	3¼ in.	-------	----------------
Providence & Spring.	------	3¾ in.	------	3⅜ in.	--------	40,000 lbs.
Concord & Montreal—						
Tender	------	3¾ in.	------	------	--------	----------------
Cars	------	4 in.	------	------	--------	60,000 lbs.
D., S. S. & A.—						
Passenger	------	3¾ in.	------	3 in.	--------	----------------
Freight	------	3 in.	------	2⅝ in.	--------	----------------
D., L. & W.	3¾ in.	------	3⅜ in.	------	--------	40,000 to 60,000 lbs.
D., L. & W.	------	3¾ in.	------	3⅜ in.	--------	40,000 to 60,000 lbs.

Total number of roads making answer to circular	24
Number of roads using iron axles only	10
Number of roads using iron axles principally	6
Number of roads that prefer iron to steel for axles	2
Number of roads that prefer steel to iron for axles	4
Number of roads answering but do not give any information that can be embodied in this report,	5

JOHN MACKENZIE,
J. S. GRAHAM,
JOHN S. COOK,
E. B. WALL,
THOMAS SHAW,

Committee.

On motion of Mr. Sprague the report was received.

DISCUSSION ON STEEL AXLES.

MR. JAMES M. BOON, West Shore—Speaking of the breaking of steel axles, there is no question but what there is considerable breaking. The true reason has not yet been fully demonstrated. It is no question where there is a sharp shoulder either on the steel axle or any other steel bar, that it will break. But with turned steel it is very indefinite. I am under the impression that one cause of steel axles breaking is that the steel is of too high a grade of hardness. I have known axles to break, of steel as fine as cutlers' steel. I had an instance a short time ago of a driving axle breaking. The axle broke simply because it was a bad job to start with. The wheel-fit was about one-eighth of an inch smaller diameter than the body of the axle. The fracture plainly showed the operation of the break. It had started on the outside and worked its way and finally had got to the point where the strength of the axle was less than the load it had to carry, and it fell off. There was no apparent reason why the axle should have broken. It was plenty strong enough. It had been run only a short time. The total mileage was about 132,000 miles. In the course of time we wished to make a particularly large cutter and the idea struck us to try this old broken driving axle. It was an experiment to start with. We didn't any of us imagine that we could make a hardened steel cutter out of the best of metal that had been used for a driving shaft. But we made the cutter 16 inches wide and 1¾ inches thick, and that cutter has now been in operation some six months, doing splendid work. It shows right on the face of it that hard steel is entirely unfit for the service of driving wheel axles where it has been applied. Steel axles under the tenders or cars break from very much the same cause. There is no question about the strength. There is no reason why they should break, but they do break. There is no unusual service. The question we ought to get at is an analysis by which a formula could be established of what the steel should be.

A motion to adjourn was made.

THE PRESIDENT—Before adjourning, I want to congratulate you on this memorable occasion—the Twenty-fourth Annual Convention, the largest ever held in the history of the Association, 107 members having answered to their names.

The Convention then adjourned until the following day.

SECOND DAY.

The Convention was called to order at 9 A. M.

THE PRESIDENT—The business of the morning will commence with a discussion of the Report on Iron *versus* Steel Axles. The report is before you. Mr. West, will you give us your experience with respect to steel and iron axles?

MR. G. W. WEST, New York, Ontario & Western—I would say that we are using iron exclusively on the Ontario and Western, with the very best results. The experience I have had with steel axles will not permit me to say much for or against them.

MR. SETCHEL—I would like very much to hear more discussion on this subject of steel and iron axles. We have representatives here from some of the largest trunk lines in the country, who have had more or less experience in that direction, and I know that it is a matter of inquiry among a great many master mechanics as to the facts of the case, and many have come here for the purpose of getting that information from those who have had experience. Mr. Cromwell, of the Baltimore & Ohio, is here, and Mr. Garrett, of the Pennsylvania.

THE PRESIDENT—I will call on Mr. Swanston to give his experience on iron and steel axles.

MR. WILLIAM SWANSTON, Chicago, St. Louis & Pittsburgh—I have no data whatever to give the Association. I did not answer this report, for the simple reason that I had no correct information to give. We are using nothing but steel axles now for any purpose. There are light classes of locomotives that use iron axles still, as standard, but as a rule it is steel axles for everything. For my own individual opinion, not based upon any correct figures that I have taken or experiments that I have made, but just from general observation, I would say that as a rule brasses wear faster on steel than they do on good iron. I have had some experience in which I saw steel axles reduced in diameter faster than iron that was properly made. My experience is also that steel axles will break in less time than the average iron axle, but that their average life is nearer uniform than iron. These are gen-

eral observations that I have made, not based upon any close calculations or any close record.

MR. A. W. QUACKENBUSH, Chicago & Alton—We are using the best hammered iron for axles on cars and engines, and also for crank pins, and we have found that they have done better than steel. We had one 7½-inch steel axle in a mogul engine that made only in the neighborhood of 30,000 miles and broke. It was a new engine. Mr. Sinclair saw the engine several times, and I compared the axle with the McQueen axle that had been on another engine twenty years. The steel axle had worn ⅜ of an inch and the iron axle had worn $\frac{3}{16}$ of an inch. Of course, you understand that this old engine was a lighter engine, while there was not much difference in the weight on the journal on account of it being a mogul engine that broke, and the other being an eight-wheel engine. The other had run continuously for almost eighteen years.

THE PRESIDENT—I would like to hear the members express themselves freely on the subject. Can Mr. Cromwell tell us about this?

MR. A. J. CROMWELL, Baltimore & Ohio—I would be very glad to give you information. We have only just introduced the steel axles on our road. We used iron axles previous to that.

THE PRESIDENT—Mr. Meehan, will you favor us by rising to your feet?

MR. JAMES MEEHAN—I can give you very little information on the subject, as we do not use steel axles or steel pins. The only point that I can give you is the fact that a certain road equipped a portion of their equipment with steel axles which had been running over our system. In ten years they have had eight broken axles on the freight equipment—none on the passenger.

MR. LAUDER—This question comes up almost annually to be discussed. I can remember back fifteen years ago when steel was first being introduced for various purposes, in connection with locomotive construction, and I am interested to look back and see the change of sentiment that has gradually taken place in favor of iron for axles, crank pins, piston rods and other appliances on the locomotive. I apprehend that where steel is used, it requires very much more scientific and closer designing than where iron is used. I believe that a steel driving axle can be so designed as to be no larger than an iron axle, and can be so carefully designed that it might hold as well as an iron axle. But all the designers of driving wheel axles are not scientific, expert designers; and it is very much safer, in my opinion, for the master mechanics of this country to use hammered iron for everything connected with the locomotive, almost, except the boiler, than it is to be using any kind of steel that has ever been brought up. Steel is essentially of a granular nature. Iron is fibrous, brought about mainly by its manipulation. I suppose that steel casting could be so manipulated and worked that it would become to a certain extent fibrous. But as it is worked, especially in forgings, it is essentially of a granular structure and very much more liable to break, I think, than iron.

I think the members will agree with me, as a rule, that the experience of the past fifteen years shows that there is no grade of steel manufactured to-day that is as fit or as safe to use in driving axles, truck axles, piston rods and crank pins, as good hammered iron. To refer back to what I first said, and to emphasize that, I think that a good many of the breakages of all of these things mentioned are due to bad designing. A man who would design a driving axle of steel with sharp shoulders, turning down his wheel-fit perhaps half an inch below the journal and expecting it to hold, is looking for something preposterous. No steel made—I do not care what the size is, under those circumstances—would run a great while without breaking. One thing more. I presume it is well known by the majority of our members, and perhaps by all of the members, that in England where they pay very much more attention to close scientific designing than most of us do, they make the wheel-fit for the driving axle, as a rule, one inch larger than the journal. We ought to do it here, and I do not know why we do not. They make it one inch larger than the journal; then put in a good, big, easy fillet. If we did that, broken driving axles, either steel or iron, would be almost unknown.

MR. WILLIAM SMITH, Chicago & Northwestern—I would like to ask about the mileage or age of a driving axle. We limit ourselves to ten years. If anything shows defective before that time we take it out. But even if they are ever so sound at that period of service, we take them out. We shoulder our axle in the centre of the wheel hub, and the fit is straight throughout. With our engine and tender trucks when they show a quarter of an inch reduction in wear, we condemn them.

MR. WEST—I found when I went on the N.Y., P. & O. that Mr. Fuller was practicing that same design—boring the wheel centres, and we never had a journal break at the hub.

THE PRESIDENT—I understand you to say that the core is continuous.

MR. WEST—Yes, sir; so that the journal and the wheel-fit would be of the same diameter at the face of the hub. The shoulder was about half way in the wheel centre.

MR. SETCHEL—It hardly seems to me a good reason for doing a thing in this country that they do it in England. I do not think we have any data to show that an abrupt change in the line of the driving axle is a good thing. On the contrary, I think it is a very bad thing, whether you make the fit larger than the journal or the journal larger than the fit. The gentleman who has just spoken strikes the right key-note, in my judgment. The axle should be put on without any shoulder. The trouble is where the line of the axle is interrupted. A good many years ago when we first commenced laying steel rails, the first rail that broke on the road with which I was connected was where an engine had been derailed and the truck in passing over the rail made a strong indentation on the web of the rail. It broke right at that point. It was shown then that steel is very liable to break at any point where there is a reduction of

section. Now certainly there can be no good reason for making the wheel-fit larger than the journal.

Mr. Lauder—With reference to that, I can see a very good reason for doing it; with all due respect to my friend, Mr. Setchel. Mr. Setchel and I usually agree upon mechanical points, and to a certain extent we do in this case. I can see a good reason why the wheel-fit should be made as I described it. Suppose you have an 8-inch journal; it certainly cannot weaken anything to enlarge the wheel-fit to 9 inches. Besides, you get an opportunity for a large fillet, a smooth, clean, large fillet, in the corner where the strains are all liable to be concentrated, which must be better than a great shoulder on the wheel-fit reduced in diameter, and possibly better than a straight fit. A straight fit is what we are all aiming at now, if we give the thing any thought. But I am not certain but that we could well afford to follow our English neighbors in this particular matter. Perhaps the gentleman's remarks might lead people to think that I am something of an Anglomaniac. Every one who knows me knows that that is not true. I am a Yankee from away back. There is not a drop in me that is not pure Yankee. I missed being a foreigner by about two years.

The President—How long did you say? I want the stenographer to get that right. (Laughter.)

Mr. Lauder—About two years. But, joking aside, if we see anything that is worthy of endorsement in the design of locomotives in English practice, I think we ought to adopt it. Goodness knows there is enough in their designs to reject. In regard to that matter that Mr. Setchel condemns, I am inclined to endorse it, at least in theory. I do not practice it, because I do not think it is of enough importance to waste much time on. As Mr. Setchel says, a straight fit and get the axle big enough—that is about the proper thing to do. There is very little danger of getting the driving axle too large. But why put in a 7-inch axle when all our experience in the past shows that we need an 8-inch axle, and there is no objection to putting it in at 9 inches? The bigger you get it, the more uniform it will run, the less friction, the less wear, and, of course, with an increased factor of safety.

Mr. Sprague—I do not suppose that my experience in this matter would be of much account, for the class of engines that I build are so differently proportioned from the road engines that we have hardly a basis for comparison. But I use steel for axles and pistons and crank-pins and everything of the kind, and I have no trouble in breaking. Perhaps the reason is that they are larger in proportion to the other parts. But I believe that steel is coming. I think we ought to be slow in condemning it, for it seems to be the coming metal. While we are not entirely out of puddled iron, it seems to me that it will be very scarce one of these days.

Mr. Wm. Smith—Broken axles are a thing of the past with us, and we have a very hard road-bed sometimes, especially during a dry season. We

have experienced no trouble since we began to condemn them after certain service. Previous to that we had a great deal of trouble with axles.

MR. JOHN HICKEY, Northern Pacific—It seems strange to observe the difference of opinion as to the difference between steel and iron. Now a steel axle that will bear a certain number of blows and stand the tests, would wear, it would seem, as well as an iron one. Isn't the difference in the wear of these axles due to the difference in the quality of the steel? I see here that the Committee says there is a conflict of opinion among our members as to the relative value of iron and steel. Several of them say that steel gives a better service, while others say the reverse. Now isn't that due to the amount of carbon or other hardness in the steel? We all know that there is just as much difference in the manufacture of steel, at least in the quality of steel, as there is between iron and steel, and if that is true, we must get different results from the different qualities of steel. The greater the tensile strength of steel the higher the carbon, of course, and the result must be that it will give better wear. The lower the amount of carbon the nearer it approaches iron; and it will give results nearer to the results of iron. So it seems to me, in speaking of steel axles, we ought to say what the quality of the steel is—whether or not it is low in carbon. I do not think we ought to pass upon anything of that kind without saying what the quality of steel should be.

SECRETARY SINCLAIR—In regard to the matter of the quality of steel which Mr. Hickey has brought up, I think that those who use steel axles ought to pay very strict attention to the kind of steel that is supplied in the axles. I know that Bessemer steel is being largely used for the manufacture of car axles, and all of you know that Bessemer steel as a rule is not very reliable for machinery purposes. It doesn't seem to me to be a steel that should be used for the purpose of making axles. I know one particular case where very few of the axles ordered for cars would stand the ordinary drop test. In this test the failures were nearly all of Bessemer steel axles, and they were so numerous that it seemed as though every one of the axles ought to have been rejected. The steel question has had a new life put into it within the last few years from the fact that fairly good steel can now be supplied at the same price as good iron. If it is found that steel is more reliable than iron there is no reason why it should not be adopted, since the price is much about the same. There is no railway machinery that I know of that has to be designed with greater care as to the least possible weight than the machinery of the elevated railroads of New York. I know that that company never put a pound into a locomotive that they can keep out, and in reducing their weights to a minimum they have used steel axles entirely. They found that these very light axles had something of a regular life. They could depend within ten or twenty thousand miles on when the axle would break. That being the case, the axle is thoroughly reliable. An iron axle would sometimes stand two or three times the service that a steel axle could be depended on to endure, but it would often break at half the service and no one could figure on how long it

would run. It seems that the greatest prejudice against steel axles and all forms of steel has come from vicious forms. One cannot be around looking at crank-pins and other parts that are reputed to break badly, without seeing that many are made with shoulders where the vibration is likely to concentrate, which will eventually lead to grief soon and shorten what would be the natural life of the article. I think, if more attention were bestowed upon proper forms, that steel would take among American railroads the position it has now taken in all other departments where machinery is subjected to very severe and very trying strains.

MR. S. M. VAUCLAIN, Baldwin Locomotive Works—In the past five or six years we have manufactured some five or six thousand locomotives. We see no reason why good iron axles, provided we use good iron, should not be used. We can see no objection whatever to steel axles, provided you use good steel. We found some difficulty in getting good steel for axles. We would go to outside manufacturers, and it being impossible to test every axle and then use it, we had to rely to a certain extent on the manner in which those axles were worked and the reliability of the people from whom we purchased them. We found that it was not exactly the best thing to do. Therefore, we have adopted a policy of buying our blooms, and we have a test of those blooms made, keeping a record of them, and forging our own axles, crank-pins and everything that we make out of steel. Then we know just exactly what quality of steel we put in those things and can depend on it. During the last five or six years we have had complaints from one or two parties in regard to broken axles. I think that one was an iron engine truck axle, and one was a steel tender axle. These were all from an outside party. Outside of that we have had no complaints whatever, and we have no hesitation whatever in using steel for axles provided we have the privilege of making the axles ourselves.

MR. SPRAGUE—I would like to say that this question of the quality of steel has a good deal to do with the whole matter. Now, we built for one of our large manufacturers in Pittsburg a number of years ago a 14x20 shifting engine, and we built the boiler of Bessemer steel at their request. They were working much in Bessemer steel, and they wanted to try a boiler of that steel. We have had a great deal of trouble with that boiler. I advised the Superintendent to throw it aside. I told him the repairs would soon amount to the cost of a new boiler. I think that is one trouble with the breakages, that they do not get the right quality of steel. Of course we are rapidly improving in the quality of steel for such purposes. Mr. Lauder's practice and mine are entirely different apparently, for I make my forgings entirely of steel. Everything that I forge in one piece I forge of steel. I get more satisfactory results with case-hardened work out of this low grade of steel. I case-harden it as you do iron.

MR. ALBERT GRIGGS, New York & New England—So far as steel is concerned for crank-pins, driving axles and pistons, I have never used anything else, and I have always had the best success.

THE PRESIDENT—You use crucible steel, do you not?

MR. GRIGGS—Yes.

A MEMBER—Not for his axles?

THE PRESIDENT—I understood you to say you used crucible steel in all your work?

MR. GRIGGS—I use the best hammered steel—crucible steel.

MR. SETCHEL—It seems to me that the opportunity or necessity for correct designing is not so great in England as it is here. There is not so much of it. The duty of a locomotive is not near as hard as it is here. Our tracks require better designing than they do there, and as you use the steel, it seems to me that the kind of steel has everything to do with its use for axles and for crank-pins, both where you case-harden and where you do not. Now I have in mind large lines of road that have used a good deal of case-hardened work, that have had some experience that would rather place them on their guard against it. Steel will crack in a fine line not discernible when case-hardened, until it breaks—then it can be seen very easily. But, if you can get the right kind of steel, it will case-harden and good results will be produced. I believe that is the case in running axles. You must have the right kind of material for your axle. Some years ago, when the idea was first brought into prominence of using steel axles, and we had Vickers' steel in this country, I put some steel into a locomotive and after running a few months both axles broke, running on a straight track, without any apparent cause whatever. On taking the axles out, we concluded we would save as much of the steel as possible, and we made them into crank-pins, but they did the same thing in the crank-pins. Now that showed to me very conclusively that the steel was not the right kind of steel to use for axles. Now there seems to be just as much difference between the quality of steel for axles as there is in the quality of iron for any stated purpose.

I do not understand how Mr. Sprague can use steel so universally and case-harden it without experiencing some of the difficulties that almost every man that I have ever heard speak of it has experienced.

MR. MCCRUM, Kansas City, Fort Scott & Gulf—I agree with Mr. Setchel and Mr. Sprague on what they have said on the subject of steel. I think it depends altogether upon the quality. Now I have in the past eight or nine years used a great many low-grade steel crank-pins which I case-hardened, and which I have had excellent results from. On the other hand, I have several crank-pins in new locomotives of mild steel case-hardened, and I have had unsatisfactory results simply because, as I think, it was not a proper grade of steel. Now I have my own steel crank-pins, I cannot give you the percentage of carbon in the steel, but it is mild steel. I have had them running for six years. I have case-hardened those pins and treated them exactly as I would a wrought iron pin, and they are a perfect pin to-day. While, on the other hand, I have recently had unsatisfactory results with case-hardened steel and I infer that it is due to the difference in the grade of steel entirely.

MR. WEST—The advocates of steel axles appear to think that more depends upon the quality than anything else. Our people were about proceeding to try steel axles on a number of cars a year ago. I made several tests for steel axles, and I found that we were able to hammer some axles from the same ingot fifteen or twenty blows, while others would break at the second or third blow.

SECRETARY SINCLAIR—That was Bessemer steel, I think, Mr. West?

MR. WEST—They were made from the Pennsylvania specifications.

MR. GEORGE GIBBS—The opinion seems to be very freely expressed here that the quality of steel in the axle has all to do with the success or non-success of the service. If that is the case it would seem to be quite important to know just what the quality is. How are you going to predict beforehand the quality you want? Is it by the number of blows on a drop test? Is it by a chemical analysis? Or by fracture, or what other test? Now, in iron axles it is pretty easy to say what the best kind of iron is. But what is the best kind of steel? We have had very limited experience with steel in locomotive service. But such as we have had has been very unsatisfactory. We find it wears more rapidly than iron, heats more rapidly and is more apt to break. The heat seems, so far as we can see, a physical condition of the surface of the journal. I have never yet seen a steel journal take the polish that an iron one will in the service. The question of heating is, of course, connected with that of the surface. The question of breakage is probably that of design.

THE PRESIDENT—Let me say, here, Mr. Gibbs—you understand that the Committee in asking for answers requested the members to specify whether it was Bessemer, open-hearth or crucible steel. Now, from your remarks, I understand that you do not adhere to any particular brand of steel. There certainly is a difference there, or there ought to be.

MR. GIBBS—Our axles are Bessemer steel, I think—I have no doubt that they are—and yet it seems to me that those three kinds would not cover the past either.

MR. SPRAGUE—I have got steel blooms four or five inches square of suitable size to use for our forgings, and they are about $\frac{8}{10}$ of one per cent. of carbon, open hearth steel.

On motion of Mr. Lauder, the discussion was closed.

COMMITTEE ON RESOLUTIONS.

THE PRESIDENT—Before taking up the next subject I will announce that the Committee on Resolutions consists of J. H. Setchel, W. H. Lewis and John A. Hill, to report to-morrow morning.

INTRODUCTION OF MR. PETRI.

I have a very pleasant presentation I want to make now. Mr. Petri, representing the German Government in regard to mechanical and civil engineering, is in the room, and with the permission of the Association I will invite him to a chair on the stand. Will Mr. Lauder and Mr. McCrum kindly escort the gentleman to the platform?

Messrs. Lauder and McCrum escorted Mr. Petri to the platform.

THE PRESIDENT—Gentlemen of the Convention, allow me to present Mr. Petri, representing the German Government. He has come here to attend your deliberations and will stay during the Convention. (Applause.)

MR. PETRI—Mr. President and gentlemen of this Convention, will you allow me to state briefly my pleasure in being able to attend a meeting of such importance to railroading in America. I should like to state at this time that, as you know, the attention of all the world is directed now to American railroading, especially to motive power. We in Germany know very well how far ahead this branch of railroading has been developed here, and we know that we can learn here very much. It has been part of my study during my stay in the United States to take this subject up, and I know very well how much profit it has been to me, especially with respect to air-braking in freight trains, and with respect to large cars, heavy locomotives, heavy rails, and all these parts of railroading. We can profit very much from what you have done in these respects, and I take this opportunity of saying to you, and to all gentlemen who have been of so much help to me during my stay here, how thankful I feel for the help that I have received. I am obliged to leave this country very soon, where I have made very many friends. (Applause.)

REPORT OF AUDITING COMMITTEE.

Secretary Sinclair next read the report of the Auditing Committee as follows:

We have examined the books and accounts of the Secretary and Treasurer and find them correct.

JAMES M. BOON,
W. H. LEWIS,
H. N. SPRAGUE.

The report was received.

The next business taken up was the reading by Mr. George Gibbs of the report of the Committee on

TESTING LABORATORIES FOR RAILWAYS.

Your Committee respectfully submit the following report on the organization and province of Testing Laboratories for Railway use. There are few mechanical officers in railways who have not felt the necessity of relief from the incessant calls upon their time involved in reporting upon and deciding questions of a purely scientific nature, or those bearing upon the unfamiliar details of the industries under their charge. In addition to the time consumed, the mental strain induced by the uncertainty of the completeness and accuracy of the information obtained, leads to results which are either erroneous or of little utility. No officer intrusted with the vast responsibilities of conducting the business operations of a railway department, can devote sufficient time to the study of scientific knowledge in the engineering profession of the day, and be in a position to fully utilize its benefits. The needed relief has been sought in the establishment of a department constituting a scientific and trained practical authority in the systematic treatment of a mechanical subject. The organization and conduction of such a department, is possibly one of the most delicate specialties connected with railway work; and it is probably owing to this fact that the growth of the testing department idea has been slow. The degree of benefit to be derived from the department depends directly upon the ability, both in theory and practice, of the men put in charge. Since the investigations required are both chemical and physical, scientific and practical, it will be seen that the chief must be somewhat versed in all these branches. It is not desirable that he should be a specialist, but rather a man with good theoretical and practical education, trained to accurate reasoning and of sound judgment; he should have had broad experience and be able to generalize from the reports of his subordinates in such a shape that his statements will relieve his superior officers from the necessity of going into details. He must be able to plan methods of testing and experimenting, and see that they are properly carried out. He should not be looked upon as the adjunct of any one department in the

road, but all should draw upon him alike in problems falling in his province. It will be seen, then, that there is no slight danger in picking out a suitable head, and that an incompetent or narrow man will act as a hindrance to economical operation.

Mention has been made of the two divisions of the work to be treated, the chemical and physical; their relation to one another is in certain investigations intimate, and for this reason results in both must be combined for full understanding of the subject; in others, one branch of the department may pursue the investigation independently. In establishing the groundwork for a department, it is frequently advisable to take up one division first, both to obtain the quickest return for the outlay and to train the head for the broad field. Which division can be the more profitably started first, will depend somewhat upon the location and resources of the road; in some sections of the country, probably the chemical will produce the better results, on account of the low cost of the plant and its operation and the immediately apparent value of the conclusions arrived at, as, for instance, in investigation of the character of locomotive water supply. The physical section requires a longer time to reach a full state of efficiency and a larger working force, and although its field is much more extensive than the chemical, the good results cannot always be immediately figured in dollars and cents.

METHODS AND INVESTIGATIONS.

Your Committee believe that much valuable time has been frittered away at times in testing laboratories, by the practice of taking up work which would, of necessity, not give satisfactory practical results, or which when obtained are insignificant in value to that of the time wasted in arriving at them. Prof. Thurston, in speaking on the subject, has well expressed this idea in saying: "A vague desire to know more of any given subject is by no means sufficient to justify entering upon a work which may be found to be indefinite in its extent and infinite in its ramifications."

A list of the subjects which can, in our opinion, be profitably undertaken and which will produce results of practical value, embrace: 1st, Routine physical and chemical work, such as are indicated in appendix, of testing shipments of material kept in stock regularly and bought under definite requirements. 2d, Special work, such as tests of the efficiency of machines, boilers, fuels, improvements in mechanical construction and patented devices (whether conducted on the road in actual trial, or in laboratory), trials of water purification, tie preservation methods and others.

In the field of "special work" are embraced those subjects which admit of professional opinion without actual experiment, and for such the experts connected with the department draw upon their knowledge of the engineering practice of the day. In order to be in a position to supply such advice, the head of the department must be a hard student of engineering literature, have a library and, if possible, some regular hour of leisure to consult it. This seems to be a theoretical condition which, it is hardly necessary to say, does not generally obtain in the profession of railroading to-day.

The first matter of importance which will engage the attention of the head of such a department, is establishing standard specifications for material bought regularly and in quantity. It is a matter requiring the greatest delicacy and knowledge of all conditions in the use as well as the manufacture and market from which the supplies are drawn.

A specification, as applied to "materials," may be defined as a concise statement of certain peculiar qualities which make such material safe and valuable for certain uses. A determination of these qualities is the result of prolonged observation in its practical behavior, and study of its failures and the causes thereof. But it is obvious that *service tests* cannot always be employed to determine whether a material is fit for use, as we must know this fact *before* using it. We, therefore, strive to ascertain by quick methods of test the qualities developed ordinarily only in the course of time; in other words, substituting *indirect* tests for direct. In so doing, there is obviously danger

that we may really fail to identify a material completely from a recognition of one of its qualities only. To make the point clear by example: A satisfactory material for locomotive stay-bolts is commonly stated in specifications as one having a tensile strength of 50,000 pounds per square inch, and an elongation in such test of 28 per cent., with the additional provisions that it shall cut with a good thread and have its fracture free from lamination; a good quality of well-worked muck bar iron will fill these conditions and so will many grades of "mild steel;" but the latter material will appear from results obtained in the testing machine, so vastly superior in uniformity and the exceptional combination of high strength with great ductility, that, on the sole assumption of rigid adherence to the conditions specified, an expert would not fail to predict superior practical results from the steel. In point of fact, we know that so far steel has proved a complete and absolute failure for stay-bolt purposes. It is, therefore, manifest that our specifications are likewise a failure, unless limited to call for *iron*. We have neglected some important practical feature, some quality possessed by iron and not developed yet in steel. Now, the above is not to be taken to imply that a steel will not ultimately be found suitable for stay-bolt purposes, or that when found, a specification cannot be framed to completely identify it and to exclude unsuitable grades, but simply to show that we have not completely described the essential qualities of a stay-bolt material in the few clauses of our specification; the term "iron" alone embraces a list of peculiar qualities, some useful and some not, and we are taking too much for granted in assuming without investigation that a new material possesses the unnamed essential properties in the requisite degree.

Another case in point might be cited, where the depth and uniformity of "chill" on a car wheel are taken as indicative of its wearing quality; experience has shown that "white iron" may frequently vary quite as much in hardness as tool steel drawn to different tempers, and its wearing value in proportion.

Your Committee are convinced that only by full recognition of the limitations of our knowledge of the behavior in use of

structural materials, can seriously erroneous conclusions be avoided in this important part of a Testing Engineer's duties, and in saying this they do not wish to be understood as underrating the value of his work in bringing out the facts developed by the best engineering practice of the day; they wish to especially emphasize the important distinction, outlined above, that his tests for quality are usually indirect ones designed to predict the service from a material without actually subjecting it to a service test.

In general, then, the first aim in framing specifications should be to obtain completely the requisite standard for quality, neither more nor less, and in so doing, to encroach as little as possible upon the freedom of the purchasing department in obtaining as wide a market as practicable to buy in. These tests for establishing quality may be drawn from various sources, and should where possible be from actual service. Having found the qualities of importance from a service point of view, these must be brought out by laboratory tests of such a nature that they can be duplicated under exact conditions each time, and be quick, handy and cheap.

A careful study of the method of manufacture of the material will often suggest some simple test for checking the adherence to the best methods. After establishing the requirements thought necessary, the views of the purchasing agent and the leading manufacturers should be obtained as to their practicability and influence upon market supply.

A standard specification should in no sense be considered final, but must be subject to alteration from time to time, as the market supply varies and as service reveals weak points.

In receiving materials bought under specifications, samples must be taken representing a certain definite percentage of shipment, and acceptance made subject to behavior of sample under test. This percentage taken will vary with the nature of the material and a consideration of the chances of error introduced.

In buying under specifications, the purchasing agent should maintain a close consulting relation with the testing department as to the uniformity and reliability of the material from different

manufacturers. The head of such a department keeping a close watch of the behavior of the material under test and under all conditions of manufacture and use, should be able to draw valuable generalized conclusions to be obtained in no other way. From this it will be seen that the relations between the purchasing and testing departments should be close and cordial, each recognizing in the other the labor-saving advantages of their work and pulling together for the benefit of the road.

As to the attitude of manufacturers towards the department, our inquiries among a considerable number of the larger and better class, many of whom themselves pursue systematic methods of testing, lead us to believe that they are very much in favor of such railway departments properly conducted; one reason being the protection given them against unprincipled dealers by putting all upon a level.

As to the very important question, whether such a department increases the cost of supplies to railways, opinions differ somewhat. Your Committee believe, after careful inquiry and considerable experience, the cost may be very slightly increased, but not to an appreciable extent, nor to that which at first might be expected.

Among the tendencies towards lowering the cost are:

1st. Manufacturers have, when selling to meet specifications, definite knowledge of how the quality of their material will be ascertained by the purchaser, and they do not, therefore, have to make allowances for uncertainties in this respect; in other words, their responsibility is confined to filling certain definite and quickly performed tests, and the guarantee of satisfactory service is shifted to other shoulders than their own.

2d. The cost of material is not proportionately increased with a bettering of the quality, on account of the constant effort of manufacturers to meet demands for improved quality, by introducing cheaper processes.

3d. In many instances much less costly material is bought under specifications than under the old practice, where fancy prices have been paid for material which was above the neces-

sary requirements in quality and yet formerly justified where uncertainty was not permissible.

The only well-defined tendency towards *increasing* cost is in establishing a perfectly reliable standard of quality. The magnitude of this tendency will, of course, vary with different roads and can only be considered for each case separately. It will be conceded that a certain standard for quality is necessary for safety, and a well organized department establishes only this necessary grade. On the score of safety to life and property, therefore, the results to be obtained in this way from a testing department would seem to constitute one of its most valid claims to our consideration. Another of the benefits—and not the least—conferred upon the railway world by the establishment of testing laboratories, is that through them manufacturers have become better acquainted with the requirements of railway practice and have been brought to modify their methods to meet our requirements, and that with the least increase of cost consistent with the requisite quality. A close watch from year to year upon the variations in the character of material received through a testing laboratory is convincing testimony to the truth of this statement.

PLAN OF ORGANIZATION.

The two branches before mentioned should be in charge, respectively, of a specialist who may be called the "Engineer of Tests" and the "Chemist;" these men should report to a general head of the department, the Superintendent, who may be related to the other officers in the operating department in a manner which is deemed locally advisable, but should be freely at the disposal of all departments to whom his work is of use.

The numerical force of a fully-equipped department on one of the larger systems of the country may comprise:

One Superintendent,

One Chemist and one Assistant,

One Foreman of Test Room and two Assistants,

Two General Assistants to the Superintendent, for special experimental work and inspection of material at a distance.

A portion of the force in each branch may usually be young men who have had good technical educations, and who are willing to spend some time in the laboratory for the practical training they will get, and at a nominal salary. In fact, the testing laboratory provides a very valuable school for training young men for usefulness in other departments.

EQUIPMENT AND COST OF SAME.

What follows under this head is considered to apply to one of the larger systems of railroads of the country. Your Committee decided not to submit drawings of plans for a laboratory, as such drawings could only be based on an ideal case which might be found unnecessarily expensive for many. In many railway shops a good building, partially used for other purposes, is at hand and may be made readily available, the requisites being sufficient room and light, water and gas for the chemical and power for the physical laboratory. In designing the chemical laboratory, the best but not absolutely essential arrangement, should contemplate separate apartments for various classes of manipulations. A moderately costly place would embody a general, or main laboratory, of about 500 square feet area, containing hoods for fume work, evaporating baths, sinks and work benches, the whole piped conveniently for water, gas and steam; an oil testing room of 100 square feet, with fire-proof floor and hood; a balance room and office of 200 square feet; a photometric and photographic dark room of 150 square feet, and a storeroom of 100 square feet; or a floor space in all of 1,100 square feet, say 22x50 feet.

The cost of such a laboratory, exclusive of building and partitions, will be as follows:

Apparatus; weighing balance, glass and platinum ware, etc.	$400
Chemicals	200
Total	$600

If photometer and photographic apparatus be added	150
Total	$750
Cost of special benches, hoods, furniture and gas, steam and water connection will vary, but average	400
Total for fitting up and equipping laboratory,	$1,150

The plan of the physical laboratory may be of a simpler character, comprising a general test room, 20x40 feet, 800 square feet area, and a small office, 12x15 feet, 180 square feet area. The test-room must contain power shafting, either from main engine of shops or from a special motor, for running machines, and a vise and work-bench. The least amount of equipment considered by your Committee satisfactory, is as follows:

A 200,000 pounds screw-power vertical tensile testing machine, arranged to take tensile specimens up to 4 feet in length, and transverse and compression tests of any desired length; a screw-power machine of same type as the above, of 50,000 pounds capacity, to be used in light work where the heavy parts of the larger machine impair accuracy and consume time in handling; a hydraulic spring-testing machine of 60,000 pounds capacity, with registering apparatus, scale-beam for weighing stress, and weighted arm to test quality of motion when desired; an axle drop-testing machine arranged for testing axles and springs; a car wheel drop-testing machine. A friction oil-testing machine would be a valuable adjunct, if one could be had which would give results under conditions comparable with those of practice, or even results under certain ideal conditions, if these results could be always duplicated by different observers at different times; your Committee know of no machine on the market which properly fulfills these conditions. For the miscellaneous outfit is needed a set United States standard male and female gauges, both screw and blank, up to two inches diameter, and a set of stay-bolt tap gauges; a Vernier micrometer gauge for taking sections and a set of scales and machinists' tools. For

special work of an experimental character, a varied equipment would be needed, suited to the circumstances; this equipment would embody a steam-engine indicator and rigging, apparatus for boiler tests, dynamometer car, etc. Some roads have followed the practice of having the test-room prepare the specimens and have provided a small machine shop with lathes and planers for same. This practice, while it has some advantages, does not seem to your Committee generally warranted, when the general machine shop is at hand and can be conveniently and economically drawn upon for machine work when needed. The cost of apparatus for a physical laboratory would be, according to the above list:

200,000 pounds tensile machine	$2,350
50,000 pounds tensile machine	750
60,000 pounds spring tester	720
Axle drop-tester	250
Steam-engine indicator	70
Wheel drop-tester	100
Standard gauges	200
Micrometer gauges	40
Scales and tools	20
Shafting and belts	150
Total	$4,650

In addition to the equipment and room above provided for, the Superintendent of the department should have an office, which, besides the usual fittings, should contain a cabinet for storing specimens of various materials and parts of machines which have shown abnormal results in practice or defects in structure; also a good working library of scientific and technical books and periodicals.

In conclusion, your Committee desire to say that they have felt unable in the limits of this report to set forth the scope of the subject as completely as they desired. Feeling as they did the great money and labor-saving possibilities of testing laboratories for railways, their desire was to fully explain in detail the

nature of this new work and the manner of conducting it, had this not led them beyond a permissible length in so treating it.

If, however, they have succeeded only in arousing interest in the subject and a desire to examine into its practical workings on railways having such departments, they feel that they have not entirely missed a useful result.

GEORGE GIBBS,
L. S. RANDOLPH,
GEO. W. WEST,
DAVID L. BARNES,
Committee.

APPENDIX.

Under this head your Committee have grouped extracts from letters received from heads of the mechanical departments of railways having testing laboratories, manufacturers of railway material and others. No general circular letter was sent out, but information was requested from those who had had experience, or who had come into contact with testing work. Interesting letters of reply were received in this way from the mechanical departments of several foreign railways, for which your Committee wish to express their obligations. The replies received from English railways show that the Lancashire & Yorkshire, the London & North Western and the Midland Railways have established extensive testing laboratories and the mechanical officers speak in high terms of their usefulness.

G. W. Rhodes, Superintendent Motive Power, Chicago, Burlington & Quincy Railway Company—Our experience of the effect of laboratories on the price and market of railroad supplies is, that it diminishes the cost to the railroad company of its material and enables them to take advantage of a comprehensive and intelligent selection of goods without regard to the price, or the reputation of the manufacturers. We have reduced the price of our steel boiler plates very materially by means of the laboratory, and the quality of our oils, fats and

paints also has much improved. In conclusion, we regard a laboratory as a very necessary adjunct to any large railroad. It is also desirable to have a certain number of special men employed; these men may not always be actively employed, but it is just as necessary to have them as it is to have a wreck-master and his outfit. Men of this type are employed in railroad service and there is no more useful place for them to carry on their particular line of work and investigation than the laboratory. We would recommend that the extra men who are usually carried in the Engineering Department, the Transportation Department and elsewhere, be placed in the laboratory to be drawn from there when their services are required in other branches of the service.

J. N. Barr, Superintendent Motive Power, Chicago, Minneapolis & St. Paul Railway Company—I am decidedly of the opinion that the Testing Laboratory on railways has come to stay, that the results are so far very encouraging, and that we may expect still more decided results in the future.

I am of the opinion that the effect of a well conducted laboratory would be to increase the price of railroad material. I take this ground because I am of the opinion that much railroad material to-day is really too cheap to be good, or to be economical for a railroad to use.

L. B. Paxson, Superintendent Motive Power and R. E., Philadelphia & Reading Railroad Company—As a rule we have noticed but little effect on the prices of railroad materials; the fairness of our specifications and competition preventing an advance. In some few cases there has been a small increase in the first cost, but this has not been in proportion to the improvement in the quality of the material obtained. There has been an undoubted improvement in the service given by those materials which are now bought on specifications and uniformly tested.

George Gibbs, Mechanical Engineer, Chicago, Minneapolis & St. Paul Railway Company—The following table (*A*) gives an interesting summary of the amount of routine work handled for three years in the laboratory of the Chicago, Minneapolis

TABLE A.

SUMMARY OF TESTS IN LABORATORIES OF C., M. AND ST. P. RAILWAY, GIVING COMPARISONS FOR DIFFERENT YEARS.

PHYSICAL.

MATERIAL.	1888.		1889.		1890.		COST OF TEST.
	Amount Received.	Per cent. Rejected.	Amount Received.	Per cent. Rejected.	Amount Received.	Per cent. Rejected.	
Axles	6,850 axles	$2\frac{1}{8}$	8,415 axles	6.	5,927 axles	5.3	68c. per 100.
Angle bars	3,145 tons	4.	----	--	----	--	----
Bar iron	3,471 tons	$2\frac{3}{8}$	3,521 tons	4.	4,772 tons	3.9	11.2c. per ton.
Boiler tubes	11,851 tubes	17.	10,057 tubes	$8\frac{1}{2}$	6,991 tubes	7.2	16.4c. per 100.
Chain	74 tons	--	35 tons	4.	50 tons	3.7	10c. per ton.
Links and pins	773 tons	3.	434 tons	30.	722 tons	9.8	6c. per ton.
Springs, helical	18,589 springs	$2\frac{3}{4}$	11,539 springs	--	20,573 springs	15.2	40c. per 100.
" elliptic	1,150 springs	14.	1,441 springs	.7	1,839 springs	.6	$1.50 per 100.
Steel, plate	910 plates	4.	694 plates	3.	956 plates	7.2	23.4c. each.
Track bolts	2,910 kegs	--	2,423 kegs	--	5,053 kegs	3.8	92c. per 100 kegs.
" spikes	4,617 kegs	--	7,999 kegs	--	14,235 kegs	15.5	16c. per 100 kegs.
Wire, barbed fence	3,958 reels	--	11,425 reels	14	6,838 reels	--	8c. per 100 reels.
Turnbuckles	----				1,260 pieces	--	10c. per 100.
Taps, dies and reamers	----				384 pieces	5.	$3 per 100.

TABLE A.—*Continued.*

SUMMARY OF TESTS IN LABORATORIES OF C., M. AND ST. P. RAILWAY, GIVING COMPARISONS FOR DIFFERENT YEARS.

CHEMICAL.

MATERIAL.	1888.		1889.		1890.		COST OF TEST.
	Amount Received.	Per cent Rejected.	Amount Received.	Per cent. Rejected.	Amount Received.	Per cent. Rejected.	
Antimony	44 casks .	--	18 casks .	--	29 casks .	--	
Lead and tin	3,224 pigs...	--	1,540 pigs...	--	1,599 pigs ..	--	
Wire, barbed fence....	3,960 reels..	--	11,432 reels..	9.69	6,438 reels..	--	
Springs, helical	18,589 springs	3.33	11,539 springs	--	20,573 springs	14.48	
Oil, lard	485 bbls...	--	353 bbls. .	--	405 bbls...	--	
" linseed	460 bbls..	--	522 bbls...	--	480 bbls...	--	
" headlight	6,872 bbls...	6 78	6,805 bbls...	3.65	8,858 bbls...	12.64	
" mineral seal	2,288 bbls...	23.21	1,977 bbls...	6.07	1,651 bbls...	7.27	
" valve	1,565 bbls...	--	1,445 bbls...	--	1,040 bbls...	--	
" turpentine........	91 bbls...	--	93 bbls...	--	78 bbls...	--	
Soap, common	....	--	....	-	....	--	
" toilet..........	41 gross .	--	64 gross..	--	116 gross..	--	
Soda, caustic	66 drums.	--	101 drums.	--	87 drums.	--	Season 1890 not favorable for water analyses.
" ash............	111 bbls...	--	153 bbls...	--	141 bbls...	--	
Water	90 s'mpl's	--	74 s'mpl's	--	40 s'mpl's	--	

Total number of analyses in 1890, 589, representing 1829 determinations of elements.

NOTE—Rejections of material which were tested both chemically and physically are charged in this table to the department in which requirements failed to be filled; thus for springs, the physical rejections are in addition to the chemical.

& St. Paul Railway, but does not include a large number of special tests made in both laboratories, nor a list of the experimental investigation being constantly carried on. The work handled during the present year (1891) will show a large increase over that of previous years on account of the material received for new work in building cars and locomotives. The material tested in each year does not accurately represent that used during the period for the reason that the amount of stock on hand may happen to vary at the beginning or close of the calendar year.

It will be noted that the percentage of material rejected on test appears to be very irregular and would not seem to bear out the facts we have noted, that we are receiving better material with less trouble year by year. This irregularity is due to several causes, the most active being the change in the market from which the supplies are drawn, and the receipt of material from new manufacturers who are not fully conversant with our requirements.

In the last column of table, I have given the approximate cost of making a test on the basis of the quantity of material represented by our unit of test. The cost in each case includes labor in fitting up specimens when such is required. In the chemical work no figures for cost have been given as the cost will vary enormously at different times, depending upon the distribution and amount of work in hand. In chemical, unlike physical work, one man can carry on several analyses simultaneously. The inspection of material on this road is carried on almost wholly at our own shops. This plan we have found much cheaper than the one pursued by some other roads, where a corps of inspectors are employed and test at the mill. The latter plan, however, might be as cheap as ours, if we were situated nearer the centre of supply. In our case manufacturers are obliged to pay return freight on material rejected, which would naturally make them more careful not to send defective material. The greatest objection to the plan of testing at the railway storehouse is that we are sometimes inconvenienced by the delay in getting rejected material replaced.

L. S. Randolph, Engineer of Tests, Baltimore & Ohio Railroad—The following tables (*B* and *C*), furnished by Mr. Randolph, of the Baltimore & Ohio Railroad, are of further interest in connection with those given above for work done on the Chicago, Minneapolis & St. Paul Railway.

TABLE B.

SUMMARY OF PHYSICAL TESTS—FISCAL YEAR 1889–90.

MATERIAL.	No. of Tests.	Quantity represented.	Accepted.	Rejected.
Axles, steel	104	3,856	3,257	599
Boiler steel	1,089	807,352 lbs	771,051 lbs.	36,301 lbs.
Cast iron	126	General Foundry use.		
" wheels, 33"	806	40,532	39,591	941
" " 31"	71	3,022	3,017	5
" " 30"	8	488	487	....
" " 28"	2	101	101	....
" " 26"	9	531	526	5
" " 24"	4	205	205	....
Chain	476	214,114 lbs.	175,513 lbs.	38,601 lbs.
Coupling links	33	3,750	3,750	....
Steel forgings, crank pins, parallel rods, etc.	47	95,378 lbs.	93,678 lbs.	1,700 lbs.
Springs, helical	1,071	16,350	15,281	1,069 lbs.
" elliptic	762	762	756	6
" engine	1,675	1,675	1,657	18
Stay bolt iron	70	69,727	60,042	9,685 lbs.
Splice bars	56	74,795 prs.	74,795 prs.	....
Tire steel	192	548,268 lbs.	539,748 lbs.	8,520 lbs.
Wrought iron, merchant bar	2,332	7,660,508 lbs.	5,194,313 lbs.	2,466,195 lbs.
" " " "	Accepted without test on account of urgency		....	180,578 lbs.

EXPERIMENTAL TESTS.

MATERIAL.	No. Tests.	REMARKS.
Axle, broken driving	5	....
" " engine truck	2	....
Boiler iron	5	Exploded boiler.
Brasses	28	....
Coupling links	6	....
Cast iron	6	Broken wheel.
Side rods	6	Engine 824.

MOUNT CLARE, BALTIMORE, MD., October 9th, 1890.

TABLE C.

REPORT OF WORK DONE IN CHEMICAL LABORATORY FOR FISCAL YEAR 1889–90.

	No. of analyses made.	No. of elements determined.
Spring steel	76	295
Tire steel	61	306
Water for boilers	52	322
Water for sanitary purposes	4	20
Waste	33	124
Brass and alloys	14	43
Burning oils	33	198
Lubricating oils	37	160
Miscellaneous	61	197
Total	371	1,665

Tests of oils, 326.

Prof. J. B. Johnson, of Washington University, St. Louis—Probably the greatest advance to be made in the next half century in engineering will come through a better knowledge of the nature of engineering materials and the way stresses act upon and effect them. There are hundreds of unsolved problems in railway operations, many of which could be run down and solved in a Testing Laboratory, provided it is managed on scientific principles and not as an office or shop where only certain standard tests of a rude nature are carried out under fixed instructions by half-educated employees.

N. K. Fairbanks & Co. say, in reply to a question as to the effect of a well-conducted laboratory on the price and market of railroad material: "This question must be answered with the assumption that the test to which the materials will be subjected is practical and not theoretical. It is well to have ideals, but specifications must not idealize the Purchasing Agent out of the market. We believe that proper tests, properly conducted by railroad companies, are highly to be commended for the following

reasons: *First*, they insure the road the economy arising from the use of good material; *Second*, they put all manufacturers on the same level before the Purchasing Agent, and manufacturers of honest goods will have a chance for consideration, while poor and comparatively worthless goods will take no place in competition; *Third*, if railroads require goods of a high standard of quality manufacturers can be found who will meet the standard. Of course higher prices will be charged, but the goods will be worth more. Competition between manufacturers will keep prices within proper bounds and the tests conducted by the railroads will show whether they can pay the advanced prices for better goods or not.

Pencoyd Iron Works, Philadelphia, Pa.—We believe the greatest benefit to be derived by the establishment of proper tests and inspection by railroad companies of all classes of material, which we believe to prevent improper competition and ensure to the purchaser a much better quality of article without any increase whatever in the cost of same. We also believe a thorough inspection and test by the purchaser to be a great safeguard to the manufacturer desiring to place upon the market a thoroughly reliable product.

Schoenberger & Co., Pittsburgh, Pa.—We feel certain that the establishment of tests by railroad companies will be of great benefit to the consumer of structural material as well as to the conscientious producer of such. Strict and careful examination will necessarily be connected with expenses, and the cost of production being considerably increased, the price of such material may be slightly higher than that of material made with less care. For our part, we greatly prefer to furnish our locomotive steel to companies making thorough chemical and physical tests of it.

DISCUSSION ON LABORATORIES.

On motion of Mr. Sprague the report was received.

MR. SETCHEL—We have with us several associate members. A number of them are familiar with this subject, and it seems to me to be right in their line, and I think now is a good opportunity to make use of them. My friend

Forney here has not been heard during this Convention, I believe, and I should like to hear from him especially.

MR. M. N. FORNEY—So far as my knowledge of laboratory practice has gone it has been somewhat like that of a looker-on. I have never had any practical experience, myself, with laboratory practice, but from intercourse with various persons who have been engaged in laboratory practice, I can say that there are experiments in the first place which undoubtedly result, in the hands of experienced and proper persons, to very great advantage to railroad companies. On the other hand, there are cases, I think, where investigations are placed in the hands of incapable persons, whose heads are not very clear, and who are not capable of conducting investigations properly. That results in a waste of money. The fact is that some of the older members may remember that a good many years ago there was a scheme, of which I was partly the author, of creating a mechanical laboratory in connection with the Master Mechanics' Association, and the plan was discussed in various ways, and it was suggested at one time that we should establish a mechanical laboratory on wheels, that we should have a car and fit it up with a laboratory, and keep it going about the country to various places and have experiments conducted in the car as they might be required for any of the railroads in the whole country; but, fortunately for myself and fortunately for the scheme I think, there were some gentlemen connected with the association who had much longer heads than I had. Mr. Hudson, I remember, of the Rogers Locomotive Works, and Coleman Sellers, pointed out the extreme difficulty of carrying out such a scheme through the instrumentality of the Master Mechanics' Association.

I think the success of a mechanical laboratory depends entirely on the ability and clear-headedness of the man in charge of it, and if a laboratory were created by the master mechanics I think it is extremely doubtful whether a person would be selected who would have the necessary qualifications to carry it on. The fact is, a suitable man to make and suggest experiments of any kind is a very rare individual. If you had a dog fight out on the street and called on half a dozen of the members of the Association to give an account of that dog fight, each would differ materially from the others. The fact is the capacity for careful observation in the minds of most people is so defective, that in making experiments they do not see actually what does occur. Then in the next place, after you have made experiments and observations, it is equally important that you reason correctly from those facts that you have deduced. Now, it is hardly necessary to say that a very large proportion of mankind are not good reasoners. They draw wrong conclusions from the facts, and the result of the tests and investigations made in the laboratory would apt to be quite as misleading as beneficial.

I know one particular thing that is sometimes a little amusing. Every young man starts out in his career by being taught the great value of the indicator—if you only put an indicator on a locomotive you can find out all sorts

of things about it. I have done it myself. I have had my photograph taken standing on the front of a locomotive. I will say that I never knew any person to find out anything about a locomotive from an indicator that was worth knowing. It may be that I have been unfortunate in my observations, but that has been the conclusion they led me to. I have shown people what beautiful diagrams this locomotive made. As a matter of fact a locomotive is not made to make indicator diagrams; it is made to pull trains. In saying this I do not mean to say that an indicator is not under some circumstances a useful instrument. Undoubtedly in many cases it is. Perhaps persons have used it on locomotives and obtained information that was worth getting. I merely say that from my own personal observation I cannot recall a case now of any person who has found out anything about a locomotive with an indicator that was worth knowing.

I therefore think that this whole subject of laboratories will depend chiefly upon the person in charge of the work that is done there. I know that on the Pennsylvania Railroad very much valuable work has been done. I have been intimately acquainted with Dr. Dudley, and the other gentlemen in charge of that work, and I am convinced that that company has been very much benefited by it. I have also seen some other laboratory work that was done that was simply superfluous and useless. It was done by persons who were incompetent, either from education or nature, and the work done was merely playing with chemicals.

MR. WM. SMITH—If more careful attention were devoted to excluding bad material from railroad machinery, it would be better for all concerned. If a sound sentiment existed on this question every one would be in favor of adopting a laboratory.

MR. SHAW—I have to differ a little from my friend Forney in regard to the use of the indicator. As we get on to the refinements of the structure of the locomotive the indicator is the pulse of the work in the cylinder, and there is no other means of knowing the work that is going on in the cylinder except by the indicator. When our valves are set wrong or when we want to know any particular thing about the working of the link motion, or any alteration in the link motion, there is nothing that shows it up so well as the indicator. It is really an indispensable instrument. Sometimes I believe they attach too much value to it. I believe in making tests there should be a dynamometer used to find the total result of the work of the engine, which includes the work of the friction of the engine.

MR. VAUCLAIN—Did I understand Mr. Forney to say that he never met anybody yet who learned anything from an indicator about a locomotive?

MR. FORNEY—I made the remark that I never knew a person who had found out anything worth knowing from the indicator of a locomotive. I haven't made the statement that there had never been a case in which anybody had found out anything. But I say that I never knew a case in which a

man found out anything, that seemed to me to be really worth knowing, from an indicator.

MR. VAUCLAIN—I would like to inform the Association that I have found out a good many things worth knowing about a locomotive from an indicator. If we build a locomotive and put it on a heavy grade and we find that the engine works with difficulty, and by applying an indicator we find that we are working all the way from 15 to 30 pounds back pressure in the cylinder, isn't that worth knowing? And when we find it out, we can readily remove the back pressure. We all know that in days gone by when our rods were adjustable, an engineer would get down and alter his hooks, thinking if he gave the valve a little more lead he could get over the hill, not knowing that he simply altered the valve and made it lap over more on one side than on the other. With the indicator we have been able to determine all these conditions in the locomotive. While a locomotive may not be built primarily to make indicator diagrams, it is very essential that a locomotive should give a good diagram. Without a good diagram it is impossible to do good work.

MR. HICKEY—I do not think this Association can afford to go on record as permitting the statement to pass that nothing is to be learned by the use of an indicator on a locomotive. I have taken indicator cards from locomotives, and, for one, have been instructed greatly thereby, and have improved engines by the changes indicated by the use of the indicator. I hope Mr. Forney will see the necessity of withdrawing such a statement as that. There is scarcely a man, perhaps, connected with locomotives, who has not observed something with the use of an indicator by which he could arrange matters to better advantage than if he had not used the indicator.

MR. SPRAGUE—I am really glad to hear Mr. Forney say something against the indicator. I cannot see why the practice of men with years of experience in perfecting valve motion and finding the results in hauling trains is not equally satisfactory with the results of indicators. I confess I have never taken an indicator diagram. There has been so much of a craving for the indicator within the last three or four years, that I have been afraid that I would be forced to do it. However, one of our customers received an engine from New England some time ago, and he wrote to Mr. Porter, my employer, to know if he had any diagrams, and Mr. Porter wrote that he was ashamed to say that his superintendent was so unscientific that he had never taken any diagrams. He said that as soon as he got time he would take some diagrams. He did so, and the artiole was published in *The Railroader* some months ago, showing that the diagram was simply perfect. Now that proved that a person's experience in working out a valve motion that will pull a train and do work, will correspond with the diagram, so I feel that I am not so much behind the diagram after all, although I have never used one.

SECRETARY SINCLAIR—I would like to say one word about that indicator matter. Since I came to this meeting, a member directed my attention to some diagrams that were taken from a locomotive, and one of them had pecu-

liarities about it that he didn't understand. It was evident to any one who could read the diagram, that the engine had very contracted exhaust passages. The steam didn't get properly exhausted until it was near the period for compression. The exhaust line fell down gradually from the beginning of the return stroke almost until the period of compression. If that diagram does not point the way to changes which will be worth something, the indicator or its teaching is not to blame. The difficulty to a great extent with the use of the indicator has been, that it is not for defective locomotives that it is used, but for crack locomotives. There is a tendency to use it to show what fine cards you can get from certain locomotives, when it ought to be used to see what is the matter with the engines that are working badly. There is a useful and profitable place for indicator work, no doubt, in locomotive practice, if it is properly handled and its record intelligently interpreted. When it is evident that an engine is using too much steam an indicator ought to be employed to see in what way it is wasted. If that practice were generally followed I think the indicator would be very much more popular with master mechanics than it is. This is too late a day to assert that the indicator is not a useful instrument in steam engineering. The high class steam engine of America has been developed step by step by the teachings of the indicator. The indicator has identified faults and pointed out lines of improvement, acting as a counselor and guide to the engineers and inventors who have made the American high speed engine so successful. There is no reason why the same instrument should not be used to secure like advantages in locomotive practice. (Applause.)

MR. J. W. CLOUD—I would stand up as one who has learned something from the indicator about the locomotive. I have indicated locomotives a great many times, and I have learned a great deal by these indications. Perhaps had I had long experience before I tried indicators I should have known before what I learned from the diagrams. But I would largely have been informed by the results obtained by previous indications; and the very fact that some of these gentlemen who never used an indicator on a locomotive can get a perfect card, when somebody comes along and indicates for them, is only an evidence, to my mind, that the general practice has been advanced and made good; by somebody else's indications. Not only have I learned something of the better operation of locomotives by the use of indicators, but I have gotten information which was useful, and used to convince other men—men who were running engines, as to how they should run, and gotten evidence which I couldn't obtain in any other way, to convince these engineers in regard to the running of their engines; and I think this Association ought to be sufficiently enlightened to bear testimony to the fact that the use of the indicator on locomotives is an exceedingly important thing. If you have built one engine and want simply to duplicate it, you may perhaps copy that to advantage, and if your men are careful enough you may get proper results without the use of an indicator. But for all advances in locomotive engineer-

ing. the indicator is necessary. We are confronted now with the compound engine question. It has been largely developed already abroad, and somewhat in this country. It has only been developed along the proper lines by the proper use of the indicator, and it will only be advanced, without the unnecessary expenditure of money, by the continued use of the indicator. (Applause.)

MR. GEORGE GIBBS—Mr. Sinclair has hit my idea about indicators exactly. I have taken a great many indicator cards under all conditions. I have been asked to take indicator diagrams from engines which were doing a little better than other engines of their class, to find out what was the reason. In each case I have said that I was not able to tell from the indicator card. The indicator should be used for finding out what is the matter with defective engines. Again, if you want to find out with an indicator card if an engine is exactly square, and take cards at forty or fifty miles an hour, you will fail. That should be done in the shop. Lately we have indicated some ten-wheel engines. They had been built with larger cylinders and larger boilers than our old ones, and with higher pressure, expecting to get the advantage from the higher pressure. We learned from the indicator that these engines had too small a dry pipe. By trying the steam-chest line you can tell whether the restriction of steam is in the dry pipe or in the steam passages, in the same manner as restricted passages are shown on the exhaust line—the back pressure line. There are many useful things to be determined from indicator diagrams.

MR. MEEHAN—I am certainly under the impression that Mr. Forney is not in earnest in making his assertion regarding the indicator. He says he has used an indicator. If he has used it he cannot fail to be convinced of the utility of it. I can tell Mr. Forney several things that I have found out from an indicator. We had a class of locomotives on our system that had a very small steam pipe. We put the indicator on the engine and found that the initial pressure was 15 pounds less than the boiler pressure. We found that out by the indicator. Another case was with a class of passenger engines that we have on the line. When they would get to a high speed they had a very peculiar vibration. I thought I was an expert as to locomotive engineering and that I could detect any defects from the ordinary practice. I imagined that it was a lack of balance, the wheel was not properly counter-balanced. I put the indicator on and found it was excessive compression. Mr Sinclair happened to be at the Ludlow shops at the time I was cutting out the valve. He examined it a few moments and thought I was right about the change I was about to make. He got so interested in it that he put on a set of overalls and went out on the engine and took the diagrams himself. That cured the engine. I could name a dozen more things that I discovered by the indicator that it was not possible to find out by the ordinary practice, and I am very much surprised at Brother Forney.

MR. LEEDS—Isn't this a case where both sides may be right and both wrong? It looks to me as though our laboratory was simply a short cut to find out what would be discovered in the large laboratory of experience. If we make our test in our special laboratory we find out beforehand what is going to happen. If we try it in our experience laboratory, we find it out later. I do not think any man is likely to design an engine without being able to tell just about what the result should be, and in ninety-nine cases out of a hundred his observations and calculations will be borne out by actual experience with the engine, if she is put on the road. But I struck a case where it took me some time. This was several years ago, in fact, before I took charge. The locomotive builders in making right and left hand cylinders misplaced the passage cores contracting the ports down to about ⅞ of an inch. Those engines did very well up to thirty-five and forty miles an hour, and they were a puzzle to everybody, until eventually, after several months, we found this contraction in the ports which the indicator would have shown us the first day. The same with our contracted steam pipes. I think almost any one would have found it in time, but Mr. Meehan found it on the start. I do not think we can afford to discredit the indicator, although I think it merely indicates what our own observation will eventually show us. It brings out the defects, and I think the defects are what we are looking after. It is simply a difference of opinion as to what we can do with the steam when we get it in there and in getting it out. Mr. Meehan believes it is a great improvement to take the compression off. I think our compression gives us a hot cylinder to put live steam into.

MR. W. H. LEWIS—I do not take any delight, Mr. President, in striking a man when he is down, but I must say that I have learned something from the indicator, and I rise in defence of it. The fact of the case is, that the indicator is a photograph of the work that the engine is doing. While the methods employed for adjusting the valves are not changed by the use of the indicator, at the same time, when we take the diagram we have before us an evidence of just what that engine is doing. There were erroneous impressions that existed previous to the introduction of the indicator, which I believe were general, or at least, so far as my own experience was concerned. I will admit that I was entirely ignorant of one feature that was developed by the indicator and that was the feature of compression. We all used to think that the lead of the engine, or at least I did—that the lead of the engine is what produced the cushion to counteract the momentum of the piston. We found when we put the indicator in use that there was other cushioning pressure there, independent of the lead that produced that effect. As I say, the fact that this is a record and a picture, as you might call it, of the performance of the engine is in itself a benefit.

At one time I had indicated an engine—we all know how skeptical some engineers are in regard to any new invention; any departure from the old methods; how they are criticised. The engineer in question imagined that something had been done to his engine to affect its working, and he could not

be convinced but what the putting on of that indicator had injured the working of the engine. The fact of the case was that the adjustment of the valves had not been changed. The indicator had simply been put on there to see what the engine was doing, and when the engineer had made this remark, we had the evidence of what the adjustment of those valves was in the indicator diagrams that we had taken.

MR. BARNES—It doesn't reflect much credit on this Committee to discuss such an elementary matter as an indicator. There are some matters here that are worthy of more attention. For instance, you will notice that out of 77,000 pounds boiler material, over 36,000 were rejected, and in another case more merchant bar iron was thrown out than accepted. Still another, of the railroad spikes, 15 per cent. was thrown away. Now it seems to me that 15 per cent. is a good many. If this doesn't show the value of a testing laboratory I do not know what does. During the past years several testing laboratories have been discontinued and the force reduced all around. That is a matter we ought to take some notice of, particularly when it is shown that the cost of testing boiler plate of which one-half is rejected, is twenty-four cents a sheet. The same might be said about spikes. I think we might properly discuss the usefulness of the laboratory rather than the usefulness of the indicator.

MR. LEWIS—I move that the discussion on this subject be closed and that the Committee be continued another year.

The motion was seconded.

MR. FORNEY—I would only say that I think the members perhaps have not followed very exactly my statement. It was that I had not known—couldn't recall a case of any one who had ever used an indicator and had found out anything that was worth knowing from it. That is the extent of my statement. I do not say, and will not say, of course, that the indicator may not be beneficial in some cases. If I were building a compound engine I should perhaps use it. I made my statement in rather a strong way, to excite discussion, and I think it had that effect.

MR. SPRAGUE—I feel about the same as Mr. Forney does. I do not undertake to ignore the indicator altogether, but there seems to me to have been a sort of indicator craze for the last four or five years, and a great many men imagined that they could run a railroad with an indicator and nothing else. While I do not ignore the indicator, I think it has been carried to extremes.

I want to say a word further about a chemical and mechanical laboratory: that while I recognize the difficulty of establishing it, I recognize its importance, because there is a great deal of material, notably boiler plate, with respect to which the builders are at the mercy of the manufacturers. We do not use any new make without having a test made ourselves. It is not absolutely safe to depend upon the manufacturers' tests—although some of them are thoroughly reliable.

MR. LEEDS—I merely want to call the attention of the Committee to one fact, and I hope it will be the same Committee continued another year, I would

like to ask them to investigate this reduction of laboratories—this doing away with them; to see how much of the expense which has been taken off by the reduction of laboratories has been thrown onto the mechanical department. I know that where they do away with their laboratories they expect us to make the tests instead of the laboratories, and we do not get credit for the extra expense.

MR. GEORGE GIBBS—I would like to offer an amendment—that the Committee be discharged. There is nothing specific that we can recommend to the Association. We have gone over the ground as fully as we feel able to, and the point Mr. Leeds mentions, I think, is hardly one we can treat in the report. The reasons for reducing the force and doing away with laboratories on railroads is hardly a subject we can make a report to the Convention upon.

MR. HICKEY—Before the closing of the discussion on laboratories, I would like to say that the report of the Committee is very able. It is a very complete report, a very full report, and I think covers the ground completely. If this Association is asked to continue the Committee, it seems to me we ought to define its duty. I cannot see a point they have left undone.

MR. LAUDER—I rise to second Mr. Gibbs' motion. My reason for that is that I think the Committee has presented an exhaustive report that really covers the ground. It has been thoroughly discussed. If they have got to go over all this thing again, they are simply thrashing over the straw. Let us have new questions put, that will possess some interest for us another year, and relieve the Committee of the necessity of going over just what we have had this year, because they have seemingly exhausted the subject.

MR. LEWIS—I object to the amendment, and in defence of the original motion I will state that I think the Committee is a good one, and that the subject is an important one. Now there is work enough for that Committee to perform in the line of the subject. Take for instance that phenomenon that was presented here yesterday of the fracture of steel at different temperatures. There are a great many such subjects that should be investigated and reported on by that Committee that would be of value to the Association, and I hope that in recognition of the very able report that has been presented by this Committee, that the Association will continue the Committee.

MR GIBBS—This subject, as we stated in the first part of our report, covers the whole range of scientific and mechanical subjects connected with railways, and if the Association wishes to continue the Committee, I would like them to at least point out some special investigation they would like us to report upon.

On being put to the meeting the amendment was carried.

REPORT ON THE DISPOSAL OF THE BOSTON FUND.

Mr. J. N. Lauder read the following report of the Boston Fund :

REPORT OF COMMITTEE ON DISPOSAL OF BOSTON FUND.

In accordance with a resolution passed at the last Convention, your Committee has conferred with the Massachusetts Institute of Technology, the Cornell University of Ithica, New York, and the Stevens Institute, Hoboken, New Jersey. The Massachusetts Institute of Technology offers to give scholarships for $5,000 each; the other two offer us four scholarships for the Fund. We recommend the acceptance of the offer of the Stevens Institute.

Your Committee would also recommend that the following qualifications be required of applicants for the benefits of this Fund. The applicant shall be a son of a member in good standing, or a son of an honorary member, or the son of a widow of an active or honorary member, who may have died while in good standing. Applicants for these scholarships shall make application to the Secretary of the Association, and if found eligible, shall be given a certificate to that effect. He shall then be examined by the school authorities, and if passed, shall be entitled to any vacant scholarship. If there are more passed applicants than there are scholarships, the applicant passing the highest examination shall have the scholarship.

In addition to the above qualifications, applicants must have at least one year's practical experience in some recognized machine shop.

J. N. LAUDER,
J. N. BARR,
ANGUS SINCLAIR,
Committee.

DISCUSSION ON DISPOSAL OF THE BOSTON FUND.

On motion, the report was received.

MR. SPRAGUE—As I understand the reading of that, there is one point, I think, which I would object to. I understood that the applicants were to be passed on simply by the Secretary. It seems to me that that ought to be a matter for the Executive Committee. It is a matter of considerable importance, and it should not be put in the hands of one man.

MR. LAUDER—The gentleman is entirely wrong. The Secretary simply passes upon an applicant's eligibility. He ascertains whether he has the necessary qualifications under that rule. That is, he simply ascertains the standing of his father. No other man can do this but the Secretary. If he is behind in his dues, the Secretary knows it; no one else can know it. He ascertains whether he is the son of an active member in good standing, which means dues paid, record clear, and everything all right. If he is an honorary member he ascertains the same. He simply ascertains the fact if this boy is entitled to any vacant scholarship. Now, the Association's duties stop when that report is made. I would not care to be the one to say whose son should have the scholarship. Let the school authorities do that. The boy goes there and submits to an examination. We want the scholars who get their education through the assistance that this scholarship gives them to be a credit to this Association, and I would move that the report as read be adopted; that is, that its recommendations be adopted, without any amendment whatever. I believe we have got it just right, and I do not believe that it is necessary to have any particular discussion. However, I have no wish to choke off any discussion of this matter. But the Committee have taken a great deal of care. We have canvassed it in all its different bearings, and certainly can get at the bearing of different plans better than can be done in open convention. And I hope that the report will be adopted and its recommendations carried out.

THE PRESIDENT—It is properly moved and seconded to adopt the report. Are you ready for the question? The question is before you.

MR. SHAW—In the selection of these candidates, I hope that the matter will not be limited to the non-payment of dues entirely. I know an instance in another society where the father had fallen down stairs and it resulted in insanity, and the children were thrown upon the charity of the world. Now, if that was the case, the man would be certainly deficient in his dues, and it would only be another disaster to refuse his children these privileges.

MR. SETCHEL—At our annual meeting in Boston some seventeen or eighteen years ago, $3,000 was left over in the hands of the Entertainment Committee. That money was put out at interest in Government bonds. It was presented to the Association, and was received by a vote of the Association and was placed at interest in Government bonds. Since that time there have been several additions made by the Entertainment Committees, and in one or two cases some personal presentations were added to the Boston Fund, until at this time it amounts in currency, as the bonds stand, to about $8,000. The older members of the Association have felt for a long time that something ought to be done with it, but we were not in a position to do much. We were not an organized body, and we had no authority of law, and we could not do anything legally. That has now been obviated by the action that was taken yesterday. We will shortly be a legally organized body, and the thing will be in good shape, and it seems to be that there could be no better purpose in the world to put this fund to than that proposed in the

resolution. It perpetuates the fund and at the same time it makes a monument for this Association that we will be able to point to with justifiable pride.

MR. SPRAGUE—I am still very much opposed to the matter being put entirely in the hands of the Secretary. It seems to me that that is all wrong. It ought to be in the hands of the Executive Committee. Whether there be any manipulation of the thing or not, there will be a feeling sometimes that there has been. And I see no objection to putting it in the hands of the Executive Committee. I therefore move an amendment that the report be accepted and the matter be put in the hands of the Executive Committee, instead of in the hands of the Secretary.

The motion was seconded.

MR. LAUDER—Mr. Sprague, I think, misconstrues the meaning or the intent of the Committee in this matter, or he would not offer the amendment. We have made a report for your consideration, and made it in such a way that no member of this Association, or Executive Committee, or anybody else in this Association, will have the slightest thing to do with the selection of a person for this scholarship, except simply to testify to the eligibility of the applicant. We make it the Secretary's duty to so testify, no matter who the applicant may be; to give a certificate that he is eligible, if upon an examination of the books he finds that he is eligible. The Secretary's duties are purely clerical in the matter. I hope, gentlemen, that the amendment will not prevail. My observation through life is that if you are going to have a thing done, and well done, you should give it to one man. If you are going to have a committee, do not make it over three if you expect to have anything done. I would rather have a committee of one than a committee of three or five to work up a report for this Association, because one can just as well get the information from the members as three can. One man always does the work, anyway, as my friend Gibbs can no doubt testify to, and yet the credit is divided by five. The Secretary in this case has nothing to do except to go to the books and see whether the applicant is eligible—not whether he is entitled to it, but simply whether he is eligible for examination. And if he passes the regular school examination and there is a vacancy, he gets it.

MR. CHAPMAN—I am under the same impression as Mr. Lauder, that Mr. Sprague does not fully understand the meaning of this. The candidate makes his application to the Secretary; the Secretary simply certifies that he is entitled to the examination.

THE PRESIDENT—After examining the books.

MR. CHAPMAN—The Examining Board of the school then examines him as to his scholarship. The Secretary has nothing further to do with it, except to certify that he is eligible to the scholarship.

MR. SPRAGUE—I am still just as firm in my opinion. I do not believe in one-man power.

MR. LEEDS—I concur in the recommendation of the Committee. I merely rise to ask Mr. Lauder if any consideration has been given to the question of limitation of age. I merely want to ask if there has been any consideration given to that one point.

SECRETARY SINCLAIR—The school limits that.

MR. LAUDER—I do not want to talk too much, but I would say to Mr. Leeds that that matter was carefully considered, and inasmuch as the school authorities regulate that, we decided to say nothing about it, but to make the matter plain, simple and direct.

MR. HICKEY—I would like to ask Mr. Lauder what serious objection there can be to putting it in the hands of the Executive Committee. It seems to me Mr. Sprague has taken reasonable ground, and some good reason ought to be given why that should not be placed with the Executive Committee. I think it would give greater satisfaction generally if such was the case.

MR. LAUDER—Our only objection to that was that we wished to simplify matters. If the matter goes to the Executive Committee in a body like ours, it necessarily has to be referred to the Secretary. Our Executive Committee is scattered all over the United States. For every application for this scholarship that may be made we cannot call the Executive Committee together. It has got to be done by correspondence, and finally the whole matter has got to be referred to the Secretary, and he is the only one that can do anything with it. As the Secretary's duties are purely clerical, I do not see why the Executive Committee should be bothered with it. Now, let the communication go to the Secretary, and he simply looks the matter right up, and if this boy is eligible he certifies to that. He has no option in the matter, whatever. The only object was to simplify it and make it so that everybody could understand it, and that there should be no delay with four or five men passing upon something that did not need any judgment. It is not a question of picking out this boy or that boy. There may be a dozen applicants when there is one scholarship. The Secretary looks up the record. He sees that nineteen of twenty applicants have requisite qualifications by reason of their father's being, under that resolution, members in good standing; the other one has not. Perhaps his father has resigned. Perhaps he allowed his membership to lapse, or there is some reason why that boy has not the qualifications. Now, it does seem to me that so simple a matter as this ought to be put right through; because there is nothing in the action of the Secretary in this matter but what is mandatory. He has got to do just what these resolutions say. There is no judgment in the matter. There is no option with him, whatever.

THE PRESIDENT—You are voting on the question on the amendment, that the report of the Committee be so changed as to put the question before the Executive Committee instead of the Secretary. All those in favor of that will signify by saying aye—opposed, no.

The amendment was lost.

THE PRESIDENT—Now, the question is on the adoption of the report of

the Committee. All those in favor of the adoption of the report will signify by saying aye—those opposed, no.

The motion to adopt the report was carried.

MR. SETCHEL—It is necessary that a little more be done in regard to this matter; and I beg leave to offer the following resolution :

CAPE MAY, June 17, 1891.

Resolved, That the President, Treasurer and Secretary be and are hereby appointed a committee to draw up the necessary legal papers to carry out the action of the Association in regard to the disposition of the Boston Fund, and when the Custodian of the Boston Fund shall be duly notified of the completion of the contract, he shall pay over the principal and interest as may be directed.

I now move the adoption of that resolution.

The resolution was adopted.

CHANGE OF BY-LAWS.

SECRETARY SINCLAIR—There was a great deal of delay yesterday in reading the roll call, and it is called for under the By-laws now at an inconvenient time, and I make a motion that Rule 5 of the By-laws be changed so that the first five articles will read:

"1. Opening prayer.
"2. Address of welcome.
"3. President's address.
"4. Roll call.
"5. Acting on the minutes of the last meeting."

THE PRESIDENT—It is a pretty hard thing to hold the people here while you are calling off 458 names. I think it would be a good thing to change the rule.

MR. SETCHEL—Under our rules this motion lies over until the next meeting.

THE PRESIDENT—This is an amendment of the By-laws, and they can be changed at any sitting of the Convention.

MR LAUDER—I think we have clearly a right to change a by-law simply by a vote of the Association. I am willing to vote for this without making any other inquiries. It is a mere matter of detail, and it has been found out by actual experience that the rules ought to be changed in that particular.

THE PRESIDENT—If there are no objections, the change suggested by the Secretary will be made. I do not see any necessity for the vote. It is just simply to change the order of business; that is all.

NEW HONORARY MEMBERS.

SECRETARY SINCLAIR—The question of electing certain gentlemen as honorary members was referred to the Executive Committee and was considered at the last meeting. I therefore, by the terms of the recommendation of the Executive Committee, propose that John Black, E. T. Jeffery, Morris Sellers, F. L. Sheppard, J. Mulligan, Jacob Johann and J. F. Divine be elected honorary members.

On vote the honorary members were elected.

A recess of ten minutes was here taken.

VOTE OF THANKS TO J. H. SETCHEL.

MR. LEEDS—I was going to ask, before we took up another order of business and left the Boston Fund, and everything of that kind, that a vote of thanks be returned to Mr. Setchel for the masterly way in which he conducted that matter. It appears that he had most to do with the handling of that for a good while.

THE PRESIDENT—I imagine that Mr. Setchel is covered with glory now, and it would not do to smother him too much.

MR. LEEDS—But the best way to keep him quiet is to smother him.

MR. LAUDER—I cordially second the motion.

THE PRESIDENT—You have heard the motion that a vote of thanks be given to Mr. Setchel for his untiring and masterly efforts in presenting to this Association a proposition for the disposition of the Boston Fund. All those in favor of the motion will please rise to their feet.

The motion was carried.

THE SHAW GAS DETECTOR.

MR. CROMWELL—Mr. Shaw, who is a member of our Association, and also a member of the Franklin Institute, has invented an apparatus for determining the amount of gas and foul air in mines. He would like to explain the working of his apparatus, either here before the whole Convention, or to the members individually. It is for you to say which you prefer. I saw it tested the other day in the presence of half a dozen other gentlemen, and I think they were all glad to see it. It would be very instructive. If it is in order to make a motion, I move that Mr. Shaw present his apparatus here to the Association and explain the operation of it.

MR. BLACKWELL—I have much pleasure in seconding that motion. I have seen the apparatus and have had it fully explained to me, with a number of others, by Mr. Shaw, and I am sure every one of us came away with the idea that it was one of the most beautiful pieces of apparatus that we had ever seen, and I am sure it would be most interesting and instructive to every member of the Convention.

MR. SHAW—Before that motion is put, I want to say, as a member of this organization, that I brought that down as a piece of private information for our Association. There is no business in it for me from this organization, but as a piece of information I think it would be valuable. I have solved the very important problem of determining the condition of the air so that is done automatically. Heretofore, to make a determination of the kind that I will show you, which can be done in a minute or two by this apparatus, required a week or two. It is an important piece of laboratory apparatus. I merely brought it because I am a member of the Association and we meet here to have a friction of ideas and know what each other is doing.

THE PRESIDENT—It is moved that Mr. Shaw be permitted to show the members during the noon hour to-morrow an instrument for the purpose of determining the condition of the air. I believe the motion is in order and the Association can entertain it.

MR LAUDER—Mr. President, I shall probably vote for the motion, but recollect we are trenching on dangerous ground—dangerous ground that we have avoided for twenty long years—of allowing anything of that kind to be allowed to enter our meeting. It will open the door to such things, and it may trouble you to shut it.

THE PRESIDENT—Article VIII. of the By-Laws plainly says that no patentees, or other agents, shall be admitted in the meetings of the Association for the purpose of advocating the claims of any patent or patentee, unless by unanimous consent. I understand from Mr. Shaw that this is not a patented machine that he wants to show us—that it is not for the purpose of drawing us out or getting any expression from the Convention. If it were so, I would not entertain the motion. But I do not understand it in that way. The question is before you.

MR. SHAW—Would it not be better to exhibit it to you, not as an organized body, but privately. I want to say that it is not an instrument for the use of the master mechanic. I brought it here for the knowledge it would give the master mechanic on the gas question.

MR. FORNEY—It seems to me the difficulty might be gotten over. I would suggest that Mr. Shaw could exhibit it at the other end of the hall this evening, not before the Association, but simply to exhibit it in his private capacity to members. I make a motion that Mr. Shaw be requested to do that—to exhibit it at such time and place as may suit his convenience.

The motion was carried.

DISCUSSION ON COMPOUND LOCOMOTIVES.

SECRETARY SINCLAIR—The business for the noon hour is the discussion of topical subjects. No subject has been handed in to me yet. But yesterday the question of the working of compound locomotives was brought up and no

one sufficiently familiar with it was here to take it up. It was suggested then that Mr. Smart, of the Michigan Central, was in a position to give the Association information on it. He is here now, and I think we will be very much pleased to hear him tell us what he is doing with his compound locomotives.

MR. BLACKWELL—As this is a most important matter, it seems to me it would be a pity to commence the discussion until we have a fuller attendance.

THE PRESIDENT—Gentlemen, there seems to be no business on the Secretary's table. You have heard the suggestion with regard to the discussion on the compound locomotive. If it is your pleasure, it will be in order to take that up. I will ask Mr. Vauclain to open the subject.

MR. VAUCLAIN—Being connected with the Baldwin Locomotive Works, the builders of locomotives, we found that the time was coming in America to take up the compound locomotive. We had carefully watched the progress of compound locomotives abroad and noted their results. Building so many different classes of locomotives as we build, having over 600 different classifications of engines, and building for some fifty-one different gauges of road, it was a very important matter for us to decide just what type of compound engine we should take up in order to meet the demands of all our customers. It is an easy matter to compound by some of the systems that prevail abroad with certain classes of engines. But, when you go to extremes, it is impossible to compound. We noted the economy that was effected with the ordinary two-cylinder compound, the credit for inventing which, I believe, is due to Mr. Hudson, of the Rogers' Locomotive Works. He was the original patentee of the two-cylinder compound locomotive, in 1867. The idea did not take at that time, but it was taken up abroad afterward and dates back quite a good many years. The Mallet System of compounding, in which resort is had to an articulated system, or two compound systems in one, is very much in vogue. Mr. Worsdell, Mr. Von Borries and Mr. Le Page have succeeded in putting on the market a very good two-cylinder compound locomotive. But, if you will take up the compound locomotives that are built there and that have been built up to the present time, they do not come up in power to certain standard engines that are built in the United States by some of the most prominent manufacturers of locomotives in this country. The idea of compounding is, as you all know, to get out of your steam all that there is in it. You cannot do away with it to a great extent. You must have enough exhaust in order to give you enough draft to generate steam from the present boiler in use. If you would undertake to do away with the exhaust, you would require to have an enormous boiler capacity in order to supply the locomotive. We found that it would be a wrong thing for us to compound our locomotives in the two-cylinder manner. When you come to compound standard engines with cylinders 22 and 24 inches in diameter by 28 inches stroke, you can see that you would not have road-width enough to put a low-pressure cylinder on one side of the engine and get by on the road. I do not think

anybody would want to use a 36 to 38-inch low-pressure cylinder for every-day use. We therefore thought we would adopt a four-cylinder arrangement, and with that idea we brought out what is called the Baldwin Compound Locomotive, of which I am the patentee. We employ a high and low pressure cylinder on each side: It has several advantages. We do away with the receiver altogether. We have immediate expansion of the steam from one cylinder into the other. Both cylinders are governed by one valve, which is balanced perfectly, and therefore takes all the strain off the valve motion. We have another advantage, which everybody will admit is a very great one, and that is, if a locomotive out in service on the road happens to break down on one side—all engines are liable to break down; the crank-pin might break, the eccentric rod might break: something of that sort—we can immediately tie up one side and come in with the other side of the engine. We have ample starting power. There is no difficulty whatever in starting the train. Whereas, with the two-cylinder type of compound there has been some difficulty in starting heavy loads and also, in starting on heavy grades.

I have brought here for your inspection photographs of a number of types of compound locomotives that we have already built, and which you can pass around, if you will. By an inspection of the photographs you will recognize the adaptability of this system to any type of locomotive that has yet been gotten up.

I do not come here to advertise our special system of compound locomotives, but I come here to ask you to give the matter of compound locomotives your earnest consideration, and with that end in view I have thought it is the duty of this Association to appoint a committee—a committee of good men who have formed no opinion of compound locomotives, whether two-cylinder, four-cylinder, or three-cylinder, or whatever it may be. We have, as you know, the two-cylinder compound running in the United States. We have the Baldwin compound. We have the Johnstone compound running in Mexico, and we have one Webb three-cylinder engine. We have been very much handicapped in experimenting with our engines from the fact that a majority of the compounds we have turned out so far have been for foreign roads, where the gauge is entirely different from ours, ranging from 23 inches up to 5 feet 6 inches. Recently we built for the Australian Government a compound consolidation engine equal to the standard consolidation engine in use in this country to-day. It happened to be a 4 foot 8½ gauge, and we thought that we would take it up and try it on some of the leading railways in the country. Through the courtesy of the Lehigh Valley Road we were permitted to take it there and work it on the Sugar Notch Grade, which is 100 feet to the mile and has nine degree reverse curves. The engine worked admirably. I have here some blue prints of indicator diagrams that were taken at that time and during other trips that were made over the Reading and the Pennsylvania Railroads. You will see that there is almost an entire absence of back pressure in the low-pressure cylinder, and that the

drop from the high pressure to the low pressure is not worth considering at all; the lines are almost immediately one upon the other (see figure 7).

The next thing to do is to take these cards taken from the compound locomotive and compare them with cards taken from a standard engine that is doing good work. There are a number of standard engines in the country,

Indicator Diagrams Taken on Philadelphia & Reading Railroad, May 28, 1891.

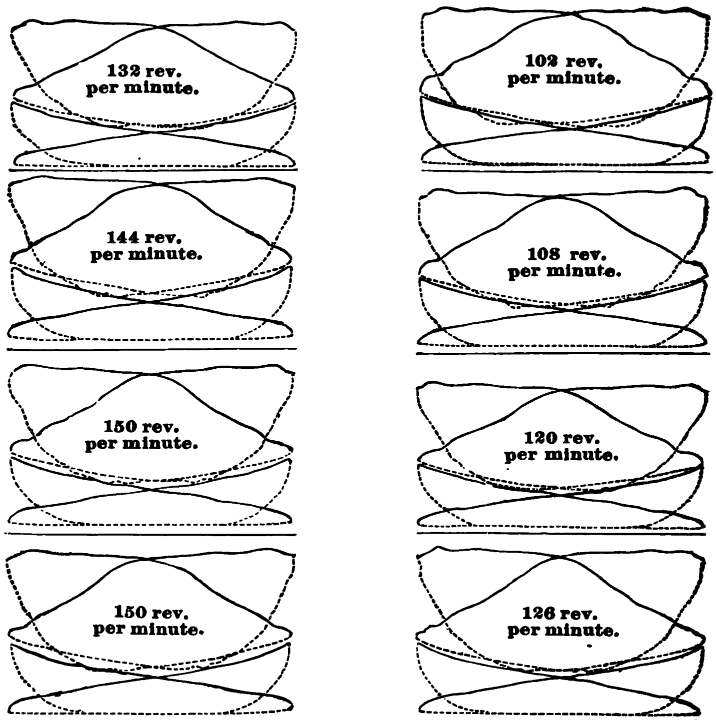


Fig. 7.

simple-acting engines that are perhaps doing very well. But, in order to consider the economical effect of a compound locomotive, you must take a first-class ordinary type of locomotive. With that idea in view, I made some experiments with an engine of that sort and compared the diagrams, of which I hand you some. I would like to call your attention to the difference in terminal pressure. In an ordinary locomotive, when your steam enters the

exhaust passages, if it enters them at a pressure of from 112 pounds down to 50, you are certainly losing a good bit of the expansive power of the steam. There is no one but will admit that you are losing a great deal of coal by letting your steam go at that pressure. It occurs to any man who has had any experience in the use of steam in stationary practice, that the thing to do is to use that steam that is exhausted at that pressure. You look at the steam gauge in almost any engine and it stands at 80 pounds. But here on a heavy grade we have known the terminal pressure to be as high as 112 pounds. Take that 112 pounds and use it in a compound engine and you get almost as much work out of your machine as what you have already done.

We have taken some indicator cards and figured up the water rate. The water rate on a standard engine and the horse power per hour varied from 26 pounds to about 30, which is very good for the ordinary engine. For a compound engine we got an indicated water rate of from 17 pounds up to 21. The economy is apparent. The indicated water rate of the engine is a good indication of the economy of the engine. If it requires more water to the horsepower in a standard engine, it certainly requires more coal to evaporate that water.

Another item is to be taken into consideration. If you have an exhaust that is terrific, that is violent; you draw a great deal of coal through your tubes. You can put on the extension front; you have got to clean it out three or four times in making a run of 150 miles, and you are annoyed with reports of hot cinders. With the compound locomotive that we have tried, we ran for three weeks. We had three or four successive attempts made to clean out the extension front. The man who was paid to do that work complained because there was not anything there to clean, and he declared that that was a funny engine that did not make any dirt, and he had no use for that engine at all. Some of the roads have to spend a great deal of money to get rid of those sparks. We got rid of them by keeping them in the fire-box and burning them up.

There is additional economy over the water economy. We find that in all our tests of compound engines there is economy in fuel. When we took this engine on the Pennsylvania we were afforded an opportunity of comparing it with the standard Class R engine, built by the Pennsylvania Railroad. It is sufficient to say that we all recognize that the Pennsylvania Railroad should have first-class motive power. When going from Harrisburg to Altoona, without taking any accurate data as to the amount of water we evaporated or anything of that sort, we used with a full train of eighty cars 13,000 pounds of coal. The locomotive built for that work with five cars less in its train used 26,400 pounds of coal. That is data that we do not care to publish. They had no representatives on their engine. We had none either. We simply took the coal ticket that the engineer showed us. Returning from Altoona, after performing on the heavy grade from Altoona, we had an accurate test made of the economy of this engine. We hauled 2,650 tons of

freight from Altoona to Harrisburgh against the Class R's 2,300, which would be 15 per cent. greater load. We effected a fuel economy of 35 per cent. Figuring on the excess of load, this would give us an economy of 44 per cent. over the Class R engine. If 44 per cent. is not worth looking after, why there is not a particle of use in further considering compound locomotives.

We have locomotives running in a great many countries in South America. We have one running in Mexico. We have made some few for this country. We have already orders for forty-four compound locomotives, and lately the orders have been coming in so fast that they have been taxing our ability to fill them at the present time, as our special machinery is not ready for properly pushing those engines through cheaply.

I would be glad to answer any questions that any member of the Association would like to ask me.

MR. BARNES—I would like to have Mr. Vauclain state the ratio of cylinder capacity he thinks is possible for compound locomotives, and just why it can not be obtained in a two-cylinder compound, if that is so?

MR. VAUCLAIN—I do not think anybody who wanted to get the best results and to utilize his steam to the utmost extent, would undertake to build a compound locomotive with less ratio than three to one. Sometimes we get a little below, but we would rather be above it. We do it to keep up a regularity of sizes. We do not wish to run into quarter inches in cylinders. We therefore take the nearest thing to it. We run all our low pressure cylinders in inches. If it runs over 22, we run to 23. If it runs over half, we go to 23. If it runs under the half we drop to 22. For our high pressure cylinder we vary in half inches. For the compound engines equal to the standard engines of 21 inches in diameter, we use high pressure cylinders of only 13½ inches in diameter. If you will notice the indicator diagrams, you will see that the steam line in the high pressure cylinder goes right straight back. You have almost the same pressure in your cylinder at the cut-off that you have at the initial part of the stroke. On a two-cylinder compound to enlarge to that extent, to use a cylinder of the ratio of one to three, it would tax anybody to know what to do with it. Where are you going to get it? Where are you going to put your truck wheels? What are you going to do with your frames? Then, again, a piston of such a diameter—say you would have to resort to 36 inches on the consolidation engine to get the ratio of one to three—that piston would have to be very heavy. If there is anything wrong with your reducing valves, you are liable to give an excess of pressure on that low pressure piston: you are going to have it break. I have no doubt if you look into the history of two-cylinder compounds, not only in this country, but abroad, you will find they have had a great deal of trouble with broken pistons. It is to be expected.

To show the inadaptability of the two-cylinder compound, I have drawn two sketches. Figure 8, in this (referring to sketch), the two-cylinder compound, is down to the lowest possible limit, which is a ratio of $2\frac{1}{10}$ to 1. You will find

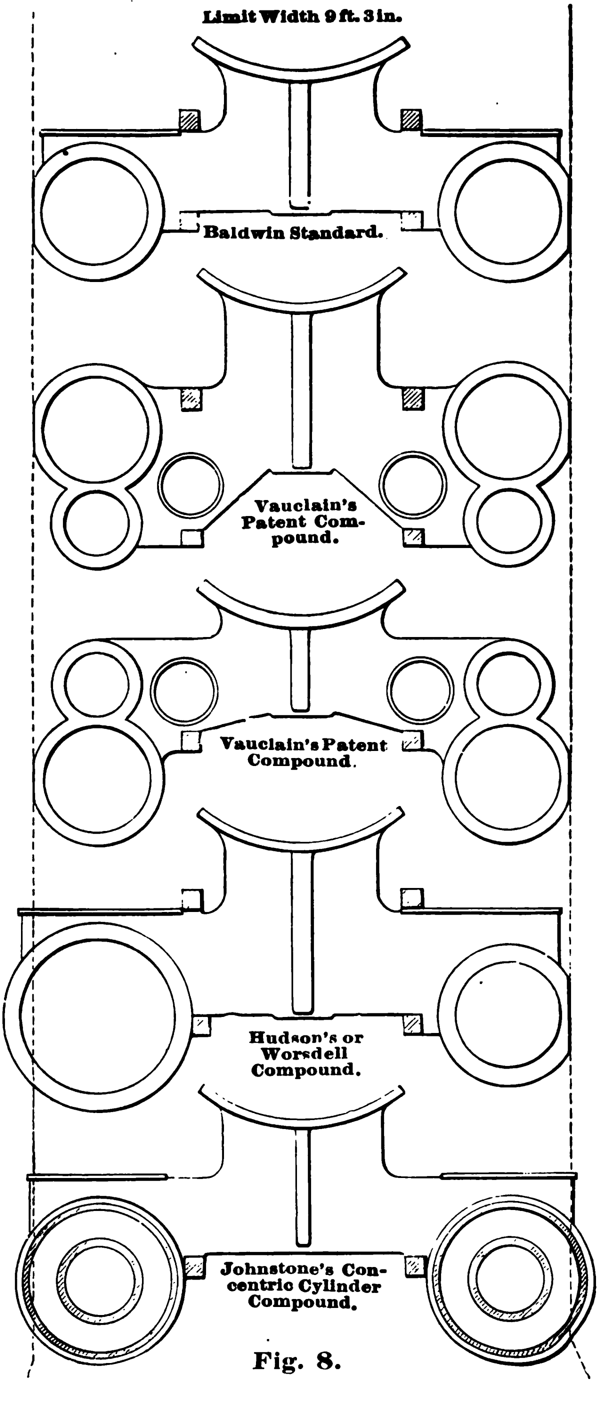

Limit Width 9 ft. 3 in.
Baldwin Standard.
Vauclain's Patent Compound.
Vauclain's Patent Compound.
Hudson's or Worsdell Compound.
Johnstone's Concentric Cylinder Compound.

Fig. 8.

there the standard engine. You will find the Worsdell system and the Johnstone system. I do not think that anybody cares particularly for the Johnstone system. The complication is something that would keep master mechanics from adopting it. The important question to be decided, it seems to me, is which is best, a four-cylinder compound or a two-cylinder compound, and which is most adaptable to all classes of locomotives now in use in this country? We at present have taken an order for five locomotives with 24-inch cylinders, 28-inch stroke, with boilers 78 inches in diameter. We are using every endeavor to have those engines compounded, as we realize how difficult

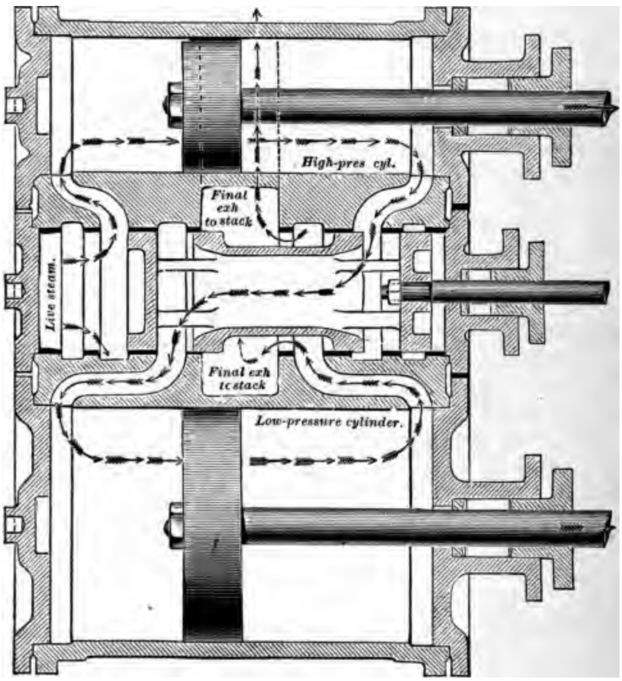


Fig. 9.

it will be for any fireman to get coal enough in that fire-box to keep that cylinder supplied with steam, when working that engine for all it is worth. We believe that locomotives were made to work, and that they should be put down to everything that their drivers will hold. I have some other photographs (Figure 9) here that were taken on the experimental trip which was made for the benefit of the Committee on Science and the Arts of the Franklin Institute of Philadelphia. We made application some eight months ago for the Elliott

Gold Medal for our system of compounding. The matter was taken up and thoroughly ventilated, and at their last meeting we were awarded that medal. The Committee of the Franklin Institute desired to know more about the engine, and we invited them to take a trip over the Philadelphia & Reading. Through the courtesy of the Philadelphia & Reading Railroad, we were supplied with enough cars to hold the engine steady from Philadelphia up. I think Mr. Paxton could answer as to the performance of that engine on that trip. Mr. Shaw, who was one of the members of the Committee on Science and the Arts, rode on the locomotive at that time. He would be a good man to call on for an expression of opinion. I have a few copies of tabulated data that we gathered when we were out on that engine, which I have for distribution. You will notice that one of these trials was made against a Wootten engine. The fuel economy there must not be taken into consideration, because the fuel was entirely different.

THE CHAIRMAN (Mr. Hickey)—I would simply ask for the information of the Association what serious objection Mr. Vauclain has to receivers in compound engines? We had a very able report upon a compound engine last year, and I see Mr. Barnett, the chairman of that committee, is present, and I think we will call upon him afterward to tell us about it.

MR. VAUCLAIN—We have this objection to a receiver, that anything intervening between the two cylinders causes a loss of power. Anything that extracts heat from the steam—anything that allows the steam to expand before it acts on the piston detracts from the pressure of the steam, and consequently from its power. I do not see that the steam can be superheated passing through the receiver at the velocity it must pass. I think if the diagrams from the two-cylinder compounds are thoroughly looked into, you will find that there is a loss of power from one cylinder to the other—a very appreciable one. Our English friends have found out that in the two-cylinder compounds they must resort to wheels of large diameter. I think it has been found out by everybody who has undertaken to use two-cylinder compounds that the larger the driving wheel, the slower the rotative speed, the better the results they obtain. We, on the other hand, do not care what size the driving wheel may be. We do not care what the rotative speed may be. We have had an engine running that got as high as 1,480 feet piston speed. That, of course, had a high rotative speed for a little more back pressure in the low pressure cylinder than we have, running at a moderate rate of speed.

If there are no more questions to answer, Mr. President, I would again state that the committee appointed to take up the matter of compound engines should be one of which no member has an axe to grind. I would not be appointed on such a committee. I would want that committee to be composed of men who had as yet expressed no opinion in favor of any particular type of compound—earnest workers, men of ability, men that could take the time. We will give them all the facilities for testing our engines, and even to the building of a compound engine and putting it at their service, if they so

desire. But we are building engines for railroads in the country to-day, that they would have no trouble whatever in getting access to, and comparing with standard engines of exactly the same size all the way through. We are building one compound for Mr. Vail, of the Western New York and Pennsylvania Railroad, to compete with his standard consolidation engines. He ordered it after riding on this Australian compound. He wished to determine how much fuel he could save over and above what he was using.

I have left the names of some gentlemen, Mr. President, you might select from. If you have nothing further for me to answer I will ask to be excused.

MR. FORNEY—I would like to ask Mr. Vauclain as to what his experience is in regard to the complications with four cylinders. Why he uses four cylinders instead of two.

MR. VAUCLAIN—That is a question which is very easily answered. The cylinder is the only thing about the engine that is to any extent complicated. The complication comes in the foundry. It requires a moulder to mould a cylinder, and the same moulders who mould ordinary cylinders mould these cylinders. I am happy to say that up to the present time, having moulded some 40 or 50 cylinders, they have not lost one cylinder. We seem to have more luck with them than with the single cylinder, for the reason that a man has to take more care in putting up his mould. The single valve causes all the ports to lead to one point. Therefore we have a greater number of cores in that cylinder than in the ordinary plain cylinder. The use of the four pistons is gotten over by coupling the high and low pistons to the common crosshead. There is no difficulty about counter-balancing. We have so arranged our locomotives that we need no more counterbalancing in that engine than in a standard engine. The high pressure piston is very small, the low pressure piston is about the same size that the standard piston is to-day in the same size engine. Our low pressure piston is only one inch larger generally than the standard cylinder of the same power of locomotive. Therefore, we are able to make the low pressure piston very much lighter than in the ordinary standard engine working at 160 pounds steam, and the combined weight of the two is just about the same as the weight of the one; it may be a trifle greater. We save something in the weight of the crossheads. We have compound crossheads that are lighter than the ordinary type of crossheads that are used on a great many engines we have built.

MR. BARNES—There are two points on which we might hear something, I think. They are the relative advantages of compounding freight engines and high speed express engines. Then, I notice Mr. Vauclain has avoided all reference to cylinder condensation, which is the mysterious element of this saving. I would like to know what in his experience is the relative advantage gained by cylinder condensation and by increasing the expansion, and further, if, in his opinion, there is any gain whatever?

MR. VAUCLAIN—I think there is a very great gain in the reduction of cylinder condensation. As a proof of that matter, in the ordinary type of loco-

motive with an indicated water rate of 26 pounds, the actual water consumption of the engine would go about 25 per cent. higher. Whereas, with a compound locomotive working the engine in the same way, with a water rate of $17\frac{1}{10}$ pounds indicated, the actual water consumption is only about 10 per cent. higher, which would give us a saving of 15 per cent. over and above the use of the ordinary type of cylinder, and this economy can come in from no other cause than from cylinder condensation. Our high pressure cylinder is always nearer the temperature of the steam that is admitted to it than the cylinder of the ordinary simple engine.

MR. BARNES—I venture to say that on these cards shown here, the water consumption as measured from the indicator, is 50 per cent. less in the compound engine than in the simple engine. Add 50 per cent. to the 15 per cent. and we have 65 per cent. It seems to me that all the saving in the compound engine would be accounted for by the simple saving on the indicator cards here given and more besides.

MR. VAUCLAIN—I think that is correct, Mr. Barnes. We have found by actual experiment that the greatest economy is to be looked for in freight service; that when you go up to high speeds—by that I mean rotative speeds—the economy decreases as you go up. You cannot look for the same economy in a high speed passenger engine that you can look for in a freight engine where the compound engine is at home. Where our compound engine is at home is on a grade with a dull, heavy drag. I would say this, that experimenting with the Australian compound, we found that we used very little more coal on a grade than we did on a level. It surprised me. I could not account for it. When I got home and figured up the water rate or diagrams the matter was explained. If on a grade you would require, say 25 per cent. more power to pull your train than on a level, and you use but little more fuel, you would certainly turn to the indicator diagrams to find out what was the cause of it. The indicator diagrams taken on the grade showed us a water rate of 17 pounds. The diagrams taken on a level, where the engine was cut back a little further, ran back to 22 pounds. There is a loss probably of 25 per cent. The 25 per cent. more fuel on the heavy grade simply made up for the loss of water consumption on the level. And where the grade exceeded the difference between the water rates as shown by the indicator diagrams, it was simply an excess of power that was necessary to move the train on the excess of grade. I think that that is very plain to you all. It requires coal to convert water into steam. If you use 17 pounds of steam to do a certain amount of work on a hill, and it takes 22 pounds of steam to do the same amount of work on a level, you have just that much economy of coal working on a hill for the same amount of work.

MR. GIBBS—During the last year the compound engine has made substantial progress. Heretofore the number of roads using them and the number of compounds in the market have been very limited, either here or abroad, and the tests received have been those furnished by friends of the engine. I do not

mean to say that the men had axes to grind. But it is well known that in the trial of new devices by the inventor, or a man who does it under his direction, he desires to get everything out of it that he can. Now, the progress has been such that it has put the roads themselves to work, and we are likely in the next year or two to get opinions which are in no way affected by the fact that they are pioneers in trying the compound idea, or that they desire to use anything except what is more economical for the roads themselves. I think we will all be struck that the water consumption is extraordinarily low for the non-condensing high pressure engine, and that the compound is very much below that more so than we should have reason to expect. We have had tests given us, published by different persons, where all the way from 30 per cent. even up to 40 per cent. of economy has been shown in the use of the compound engine, and those tests appear to make us suspect that there are other sources of economy indirectly due to compounding and not due to the action of the steam in the cylinder; that is to say, the boiler appears to be made more efficient as a steam producer. That brings us back to the action of the exhaust in the front end of the locomotive, and there is a question we should separate from the economy of the compound engine as a steam user. If there is a very large saving effected by having half the number of exhausts in the ordinary engine, shouldn't we be able to produce that by some amplification of our method of exhaust in the simple engine?

The discussion was suspended this day, owing to the noon hour having elapsed. It was taken up the following day, as follows:

MR. MEEHAN—The subject of the compound engine is getting so interesting to us all that I should like to hear from some of the parties that are now using the compound. I understand that Mr. Smith, of the Atchison, Topeka & Santa Fe, has a compound engine which has been constructed for some time, and I would like to hear from him about it.

MR. SMITH—We have one of the Schenectady compound engines running between Topeka and Nickerson in our passenger service. The engineer is very highly pleased with it. It is of the two-cylinder pattern. She is making a mileage of between eighty-five and ninety miles on a tank of water, and is burning about two to three tons of coal less than the ordinary engine on the same run. She had a 62-inch driving wheel centre, and the engineer claims that she will start the same train much easier and get under a high rate of speed much sooner than the ordinary engine.

MR. BLACKWELL—Will Mr. Smith state the percentage of saving effected by the use of this engine?

MR. SMITH—I have not got any actual data at hand to make a fair comparison. But she is burning two or three tons of coal less on the same train, the same runs, than the ordinary engine.

MR. BLACKWELL—How much does the ordinary engine burn?

MR. SMITH—About eleven tons of coal, with the very poorest quality of coal that there is there, which is about 25 per cent. carbon.

Mr. A. M. White, Schnectady Locomotive Works—In continuing the discussion of the compound locomotive I feel called upon to defend the two-cylinder type from the attack of yesterday.

I will preface by giving a short account of what has been done by the Schenectady Locomotive Works in the above line. The matter has been under consideration for some time and our Superintendent, Mr. Pitkin, visited Europe some eighteen months since to see for himself what they were actually doing, he found but very few of anything but the two-cylinder type, and he also found that the best ratio of expansion was from about two to two and a half—never over two and a half, which conclusion they had arrived at by practice.

The first engine built was a ten-wheeler, for passenger service, one of a lot of eleven then building for the Michigan Central Railroad. She was put in service some eighteen months ago, and with the exception of a few lost trips for some minor changes she has been in hard service ever since on freight and passenger. She is not running on regular passenger trains. This engine was accepted and paid for within thirty days of her delivery.

This proved so great a success that the Railroad Company ordered another of similar design which went into service nearly a year ago, and to-day is pulling the heaviest and fastest trains on the road successfully and economically, fully coming up to our expectations. In confirmation of above I would call on Mr. Smart.

In July of last year we delivered to the East Tennessee, Virginia & Georgia Railroad two compound consolidations and one ten-wheeler for passenger service. The consolidations were two out of a lot of eighteen, similar in every way except the compounding, while the ten-wheeler was like another simple engine built some time before. You can see that the above engines have had ample opportunity to be tested by actual service in competition with sister engines not compounded, of same class and train service. Not expecting that this question of compounding would come up in the way it has, I regret exceedingly that I am not prepared to give indicator cards for your inspection, but the actual daily records of the above roads on their mileage sheets show more conclusively than any other way what they are doing, showing all the way from 17 to 30 per cent. of economy, which facts have come to us unsolicited.

The following information was given me last evening by Mr. J. B. Michel, Division Master Mechanic, under Mr. Wm. H. Thomas, of the East Tennessee, Virginia & Georgia Railroad:

The percentage of saving in full for the past nine months on the ten-wheel compound over her mate, the ten-wheel simple engine, taken from the mileage, coal and oil reports was 22.55 per cent.

On the consolidation for the past eleven months the fuel saving was 17.12 per cent.

During the month of April just past, the saving in fuel on the ten-wheeler was 23 per cent., while for the same month the consolidation showed a saving of 19.5 per cent.

There has been no increase in the consumption of oil, but, on the contrary, there has been a saving in cylinder oil of 38 per cent. during the past six months. This is accounted for from the fact of the feed on the low side being reduced to nearly one-half of that of the high side.

Now, gentlemen, these are not only theoretical figures, they are facts.

We have also furnished the Southern Pacific Railroad a pair of compound cylinders which were put on one of a lot of ten 20"x 26" twelve-wheelers built about two years ago. The engine with the compound cylinders has been running in heavy service on the Pacific slope, from which we have very flattering economical reports. We also compounded one of a lot of six ten-wheelers for the Atchison, Topeka & Santa Fe. As to the merits of this engine I would refer you to the remarks of Mr. Smith, who has her at his Division.

We are now building another ten-wheel compound for the Southern Pacific Railroad and two ten-wheel passengers for the Adirondack & St. Lawrence Railroad.

The above shows the progress of the year, and most certainly there is merit in the two-cylinder compound when roads which have tried them get more and give us such facts, unsolicited.

The first argument brought against the two-cylinder compound was the inability to come in on one side in case of a break down. I am surprised to learn that this matter has been given no more thought by those making the assertion. As a matter of fact, the ten-wheel compound on the East Tennessee, Virginia & Georgia became disabled on one side while about half way out on her trip, she took her train out and brought it back again with one side. The same thing has been done on the Michigan Central Railroad.

It is conceded by all that it is bad practice to jacket a live steam cylinder with exhaust steam—please examine the cut on the cards placed in your seats yesterday and notice that high pressure steam must pass through a valve surrounded by the lowest of exhaust steam, the ports of which valve are necessarily small and divided by ribs. Need I say anything about the unmechanical device of hitching two piston-rods to one crosshead when the pressure upon them is unequal at times? Will the crosshead wear well? Need I say anything in regard to the complication and the care required for four pistons and rods when two should suffice? The assertion has been made that the pistons and rods would break on the large cylinders—this is only another mis-statement. Also, that the high piston speed attained by the use of small wheels for freight was very objectionable, this has not proved so. Objection was made to the receiver—now we consider this a good thing and it is so considered by the most prominent mechanical engineers who have looked into the matter

thoroughly. The statement has been made that the four-cylinder type was necessary because there was not room on the railroad for such spread of cylinders required by the two-cylinder type. The absurdity of this statement may be better understood when we reflect that some of the largest compounds in use have inside cylinders. This is only a question of mechanical design which we feel abundantly able to take care of.

Compound locomotives are progressing rapidly into favor among railroad men and the simpler forms are certainly the most popular and popularity is usually based on efficiency. A peculiarity about three and four-cylinder type is that none of the men having them in charge can be induced to talk favorably about them. The usual explanation of this is that railroad men are always prejudiced against improvements. Those who build the two-cylinder type find no trouble to get railroad men who use them to give expression of the faith that is within them. The engineers handling them and the master mechanics in charge vie with each other in giving testimony to their efficiency, economy and convenience. The average railroad man may be depended upon and knows when he sees a good thing and is not afraid to say so.

I thank you, gentlemen, for this privilege of correcting the wrong impression made yesterday, hoping that good may come out of it.

MR. VAUCLAIN—I would like to answer Mr. White in regard to the matter he has stated before the Convention. In the first place, Mr. White started out with the history of the two-cylinder compound built by the Schenectady Locomotive Works. I wish to say right here that we do not mean to say that there is no economy in a two-cylinder compound. We know that there is an economy in the two-cylinder compound. It was proved years ago, as far back as the original patent dates. But that economy is not sufficient, so we go to the four-cylinder compound.

The matter of surrounding high pressure steam with exhaust steam has not been correctly stated. If you will refer to the cards that were distributed, you will find that the high pressure steam comes in at the ends of the vaive, is admitted into the high pressure cylinder and is from there conducted through the valve to the low pressure cylinder, therefore at a medium temperature only as it passes near the exhaust steam; and I would like to know what engine there is in use in which the live steam does not pass in close proximity to the exhaust steam. Where is there a locomotive in which the steam passages to the cylinder or the steam chest are not directly adjacent to the exhaust passages, separated only by a thin strip of cast iron? All these matters were simply matters of detail. They are not to be discussed on this floor. They could be presented to the committee that is to be appointed. We only ask for the appointment of the committee. We do not ask for the discussion of this point to be settled here. Therefore I do not care to dwell upon that.

As to the popularity of the two types of engine, if any one has followed up the compound locomotive and read the very elaborate article printed by

Mr. Forney in his journal, written by Mr. Wallet, who has had a large experience with compound engines, he will find that altogether there have been about 750 compound engines of the two-cylinder type built. There have been a number of other types of locomotives built abroad. But we, in seven months, have booked orders for 44 compound locomotives, of all classes, and I would state right here that these are not sample engines—one of a kind to each and every road—but from one road alone we have orders for 17 compound locomotives.

In regard to prejudice—that we do not feel like asking any road that has used our locomotive for an expression of opinion, that is not so. Mr. White, perhaps, may allude to the railroad company that used the first locomotive that we built. Who built the first standard locomotive? Was there any fault found with it? The Schenectady Locomotive Works in building a two-cylinder compound engine simply perpetuate what numbers of men have done before, but by the use of a different intercepting valve. That intercepting valve which they use has been found to be inefficient, and an improved intercepting valve has been introduced in the improved compound built by the Schenectady Locomotive Works.

The Rhode Island Works have turned out a two-cylinder compound, and a very good one indeed. There is nothing to prevent any locomotive works in the country from producing a good two-cylinder compound. I have pending in Washington now patents for two-cylinder compound locomotives. We will build any type of compound locomotives. We are not here to advance any peculiar type. We are builders of locomotives for anybody who wants them, of any kind or type, no matter what it is. We have had people write and ask us what we would build a Schenectady compound for, using the Schenectady intercepting valves. We have at the present time specifications for the construction of a compound locomotive of the Worsdell type, to be run in competition with one of our engines in South America. We have running in Mexico a ten-wheel engine that is saving $34 every round trip she makes, which comes to us over the signature of the President of the road. We have a locomotive running on the Northern Pacific Railroad since last December that we have never heard a word about. We do not think it is necessary to ask about it. We have enough to do to build locomotives with our orders. If the present rate keeps up we will build in one year one-seventh as many compound locomotives as the two-cylinder people have built altogether all over the world, according to Mr. Wallet's statement. If Mr. White wishes to refer to popularity we have it right here. This matter is something that we must all be educated in. The only way to decide whether the two-cylinder compound locomotives, built under my patent, is more economical than other types of compound locomotives built, or whether my system of expansion on that locomotive with a ratio of one to three is not correct, should be determined by a committee of intelligent men appointed by the Master Mechanics' Association. We have had exhaustive reports made in regard to this question. We had one test made that cost us in the neighborhood of $4,000 and covered

a long period of time, by Mr. George H. Barres, in Boston, the most eminent authority on steam engines in the country, a man who carries an indicator in each hand wherever he goes—one man who has found out there is some good in the indicator. The Franklin Institute in investigating compound locomotives had our engine presented to them. They took the matter up. It was under discussion for a long while—for eight months. One of the members of the Committee on Science and the Arts took the trouble to go to England for information to combat it—to deprive us of the award. Other applications were made by other parties: But the Committee refused them on the ground that there was nothing there but what other people had done and on which patents had expired. I am happy to say that we were granted the highest award of the Franklin Institute for compound locomotives.

I do not see that it is necessary that any further discussion should be carried on at the present time, unless we get an expression of opinion from Mr. Hickey, of the Northern Pacific, who at the present time is running a mogul engine, an exact duplicate of other mogul engines that he has on his road, and let him say whether he knows of its performance, and I think, while I have not talked to Mr. Hickey on the subject, that the engine is doing her work so well that there has been no complaint made of it. You generally find on a railroad where an engine does her work right straight along, there is not anything said about it. If she does not do her work right along she comes to the notice of the master mechanic in charge.

MR. SHAW—I happen to belong to the Committee on Science and the Arts of the Franklin Institute. I have been a member for some twenty years. There was some opposition on the part of some of the members to granting the award and it continued for some time, and I want to say that the opposition came from men who had not examined this matter. I took occasion to ride on Mr. Vauclain's engine on the Philadelphia & Reading Railroad, in order that I might learn, as a total resultant, whether that had a good result or bad result. I want to say that the sub-committee went into the details to a great extent. I simply traveled on that engine over a road where I had frequently traveled before, and I know what an engine will do on that road, and I want to say that I was very agreeably surprised by the ease with which this engine handled her train of 246 cars, and I know at one point on the road from Exeter Junction to Reading, where some of the mogul engines will not bear to have water put in their boilers while traveling up that grade, there was no difference with this engine. I noticed in reference to the coal, in a general way, that this was a highly economical engine, and I so reported to our General Committee.

MR. LAUDER—I wonder if I understood the gentleman right to say that they had a grade on the Reading Road where they did not dare to put water into their engines in ascending the grade ?

MR. SHAW—I say from Exeter Junction up to Reading. If Mr. Paxton is

here probably he will bear me out. The engineers have told me that they would not dare put water in their engines for that period; that is, they would load up with water and avoid putting an injector on.

MR. LAUDER—This seems an extraordinary statement to make, as it is usually considered by railroad men that grades are the places where the engine needs the most water, and when they are working hard is the time to feed them, rather than to feed them after they get over the hill and when they are shut off. I think if the gentleman will give this a little consideration he will see the absurdity of that statement.

MR. SHAW—I merely make the statement that the engineer made to me. Does Mr. Paxton remember?

THE PRESIDENT—Mr. Paxton, will you enlighten Mr. Lauder on that matter? I would like to hear myself.

MR. PAXTON—We burn anthracite coal in our engines, and there are some places where the men arrange to get the fire in such a shape in going over a certain distance on the road, that they will not have to open the fire doors. It is coal and not water that they do not want to put in.

MR. SHAW—I stand corrected.

MR. LAUDER—If I am in order, I would like to ask one more question. I do so in order to have the Convention and our record show the correct thing. I would like to ask him once more how many cars this compound engine hauled over this grade. If I remember right, it was two hundred and some odd. That seemed a remarkable statement.

MR. VAUCLAIN—I think I can answer that question. The number of cars this compound engine hauled over that grade was about ten per cent. more than the ordinary consolidation. This consolidation engine was a little heavier on the driving wheels than the standard engine used by the Reading. It is not intended that the compound engine can haul any more cars than the standard engine. It hauls them with less fuel. The cars of all descriptions were ninety-two, but the peculiar classification of cars by the anthracite people made them all count 246. Some cars are classed as two, some four, some six and some only one. Employees of railroads that are engaged in the traffic can walk right along and count them up in their heads if need be, whereas to you or me it is quite a job. The weight of this train, exclusive of the passenger coaches attached to the rear end, was over 800 tons, and I call on Mr. Paxton, who can enlighten us as to the grade of the road and curvature, and also could, perhaps, give us his idea how the engine performed.

MR. PAXTON—I was, unfortunately, unable to meet the gentlemen and make the trip on the engine at that time. So from personal observation I know nothing. But Mr. Vauclain has explained to you the matter of cars all right. I presume he has about 92 in number, that odd manner of counting them making them 246. In the old history of the Reading Railroad the cars were all four wheel cars and five tons of coal to each car. We have now running 50,000 pound cars and 60,000 pound cars, and there has been some

arrangement made by which the men making up the train get a certain number of tons of coal in the train that the engine could pull. So that system of counting came in. It means 246 cars of our old kind—all four-wheel cars holding about five times 246 tons. The grade of the road from Falls to Schuylkill, or from Belmont to Exeter, six miles below Reading, is just about the fall of the Schuylkill River. It just rises with the river. In some cases the grade is flat; in some places it is nine feet to the mile. But from Exeter to Reading, up the Navesink Mountain, my recollection is that the grade is fifty-six feet to the mile, and the curvature is quite sharp in some places, and in one particular place that train would be in three different reverse curves. He certainly hauled a very heavy train.

MR. LAUDER—I do not think that this discussion need to drift into the question of the power of this engine, or the curvature or grades of the track. My question was simply to bring out the facts and I did not want it to go out to the world that we were hauling trains where the grade was so steep that they couldn't put water in the engines and were hauling 240 cars. Mr. Shaw has made that all right. He simply made a little mistake, but I wanted to put the thing right. Now with reference to these cars, we ought to be very careful in using that term "car," because it means one thing in one place and another thing in another. We have got something definite now from Mr. Vauclain—about 800 tons, and that looks reasonable and will show all right in the report.

Now with reference to this question before the Association. It has drifted, I am sorry to say, somewhat to a contest between builders of different types of engines, and parties that have patented appliances here, and all that sort of thing, which I am sorry to see. We have got a good deal of information from Mr. Vauclain and from Mr. White, which I am glad we have got, but I do not think the Association can afford to listen here to a wrangle between men who have patented articles. I believe that this Association should appoint a competent committee of the best men we have in our ranks, and the men who would be the most likely to be without prejudice in this matter, to take up this question of compound engines and report at the next meeting. I believe that the coming year the air will clear and the skies will brighten a little in regard to the compound engine, because I believe we will have run them long enough to have absolute tests made by unprejudiced, competent men, which can be presented to this Association, that we can lie down on, as the saying is, and know that they are facts; while statements made by interested parties—with all due deference to the gentlemen present—do not go for a cent in these days. There are very few of us who care to believe anything we cannot see. We are getting more conservative and we want facts. Now if a man like Mr. Gibbs or Mr. Forney, or several of our Associate members, Mr. Dean, for instance—who has tested a great many locomotives—or Mr. Barrus, who has been mentioned here. Either of those men would make an absolute test between two engines, like the case that Mr. White suggests—two

engines of exactly the same capacity, or meant to be—but one compound and the other plain, and make it fairly, covering a period sufficient to get at the fact, then we have got something that would determine the relative economy of the compound engine as against the plain. I do not think that we ought to discuss the question of types here now, because it is largely a question of interest. What we want to know is which type is the best. Of course we are indebted to Mr. White and Mr. Vauclain for some facts in that direction. So far as that goes, it is all right. But I think this Association ought to have a committee appointed—an able committee and one that will attend to its business and give us facts next year that we can discuss intelligently and all of us know that they are facts.

MR. FORNEY—I seem to have achieved the reputation of being somewhat of a mustard plaster in this Association whenever any irritation is needed. But in the present instance, I do not think that it is necessary for me to perform any such service as that, as the excitement seems to be sufficiently lively to entertain all the members present.

I got up to make a few remarks, for the reason that I have been somewhat of an agnostic on the subject of compound engines. I am waiting for what seems to me is needed, which is conclusive evidence in regard to their economy. Of course we have all seen reports from various sources in Europe and this country in regard to the economy which is effected by the use of compound locomotives. The reports vary from 10 and 15 to 40 per cent. Now the European reports, as far as I have been able to get at them, and from my recollection of them, indicate an economy of about 15 to 18 per cent. in the use of compound locomotives. There is every reason to believe that this economy is actually effected; because it is reported by a great many different people. Now if we take such an economy as that, and come down to figures, it could be stated very briefly. An ordinary locomotive in service will burn about $2,500 worth of coal where coal is worth a dollar to a dollar and a half per ton. Fifteen per cent. of $2,500 would be $375 saved. To do this you must have a locomotive which costs from $500 to $900 more than a simple locomotive. Any prudent business man would allow ten per cent. on that additional cost for the wear and tear and for the ultimate renewal of the engine, so that we must deduct $50 from our $375, which would leave $325 saving. Now I presume every man present will agree with me in saying that you can use up $325 in extra repairs on a locomotive very easily in a year. It therefore strikes me that the margin, where coal is cheap, is a very narrow one. Now of course on the hypothesis that a compound engine will save forty per cent. of fuel, as Mr. Vauclain reported yesterday, quite a different aspect is put upon the subject, and if that can be shown to be actually so, that in a fair experiment you can save from 30 to 40 per cent., why we will all be obliged to use the compound engine very soon. But if, on the other hand, the saving is not higher than 15 to 18 per cent., as the European reports seem to indicate, I am somewhat doubtful whether it will be a source of profit in

sections of the country where coal is cheap. Those are my views on the subject from having looked into it in rather a cursory way—not studying it very closely. For that reason it seems of the utmost importance to the railroad companies of the country that there should be some careful and reliable tests made by unprejudiced persons, so that it could be ascertained what the real economy of the compound locomotive is.

MR. BARNES—Mr. Forney omits to take into account the saving in repairs to the fire-box and boiler, brought about by reduction in the amount of fuel burned, which would be the case where the compound engines are used. In regard to the variation in saving, there is no reason why a compound locomotive should not show a saving of fifty per cent., providing it is compared with an engine that has been working in an uneconomical manner. There are engines on grades to-day that are working steam nearly full stroke. Now if a compound engine is compared with such an engine, there will be more than fifty per cent. saving. It seems to me that that would account for the variation in economy.

MR. FORNEY—I would like to ask where the evidence is of the saving on the boiler—whether it is not just merely a hypothesis?

MR. BARNES—The boiler is deteriorated because fuel is burned in it and water evaporated. If twenty-five per cent of the water is saved and the fire less, why shouldn't the boiler be less damaged?

MR. BLACKWELL—It appears to me that the life of the fire-box depends on the heat units. The less heat units pass through the steel the longer the life of the box will be. The more heat units pass through the shorter the life of the box will be, it seems to me perfectly plain.

MR. FORNEY—Before that is put, I would say that I understand that we have with us Mr. Hickey who has had experience with compound engines. It would be very interesting to hear from Mr. Hickey.

MR. HICKEY—I have not sufficient data to say anything on that question at present. We have an engine of the Baldwin style of compound in use on the road, but as yet we have not had sufficient experience with it to say anything about it or draw any conclusions that would be of interest to the Association now.

MR. MEEHAN—As the builders seem to take an active part in the discussion and there are some of them here, I would like to ask if they would be willing to build an engine and put it in charge of the Committee about to be appointed and let the committee take observations of the two engines built expressly for this purpose, and report at the next Convention.

MR. SHAW—I would make a suggestion for that committee—that the committee on Science and the Arts of the Franklin Institute have hunted up the entire history of compound locomotives, which I think would be useful to that committee, and I am safe to say would be at their service. And while on compound locomotives I want to make one observation on compound cylinders —that I am not the Shaw of the Shaw Engine. (Laughter.)

Mr. Vauclain—I wish to say something in regard to what Mr. Meehan had to say, that is that we are in the hands of the Committee, if the Committee be appointed, and are willing to do anything at all. I believe that what Mr. Lauder had to say is right to the point—exactly what I tried to convey to the Convention yesterday morning. We do not come here to advertise any special system of compounding. We come here merely to introduce compound locomotives to the attention of the Convention and to call their attention to the large number of compound engines that are being ordered, not by railroads in the United States, but by railroads in foreign countries. I therefore think that it is unnecessary for me to say anything further about that matter except that we will build a locomotive or we will give them permission to carry on experiments with any locomotives we have.

Mr. Cromwell—In regard to the committee, in making that test it will be well to make the test as to fast and slow speeds. We have had some little experience with one of those engines and while she did fairly well in what we term freight service, she does not do so well at high speed; so that is a matter that should be looked into, I think, for the information of the Association.

The President—I think the point is well taken, Mr. Cromwell, that the Committee should bear in mind that part of the subject as to whether they shall test the freight or passenger locomotive in the compound.

Mr. Smart—I did not intend to speak on this subject, but as that point has been raised, I wish to say that we have a compound engine of the two-cylinder type running on our Canada Southern Division, and, as this matter of speed has been brought up, I would say that this engine of the two-cylinder type is pulling our heaviest and fastest passenger train and making better time than any simple engine we have in service. We have five ten-wheel passenger engines which we consider as good as there are in the country. I would further say that on some of the divisions, as from Windsor to St. Thomas, our schedule is two hours and thirty minutes for one hundred and twelve miles, the train being composed of from seven to eight heavy cars and we are very often limited to two hours and fifteen minutes on account of delay in crossing the river, and we have made the run in two hours and five minutes—a distance of 112 miles—and running slow a distance of one mile near St. Thomas, losing at least five minutes. I have held the watch on the engine a number of times when she made mile after mile at a speed of fifty-seven to fifty-eight seconds, working very nicely and riding as well as the other engines. The first engine built has a twenty-nine inch cylinder and twenty-four inch stroke. She was put into service about a year and a half ago. She is now, and has been for some time, running our fastest trains—the North Shore Limited between Detroit and Jackson, and the weight of the train that she is handling there is 875,000 pounds, including the weight of the engine which is 206,000 pounds—that is going one way—returning with 780,000 pounds. That is a distance of 152 miles for the round trip and she makes that distance with less than four tons of coal, and she also runs two miles

from the round-house in Jackson back and forth, and eight miles in Detroit back and forth, making a total of 162 miles with four tons of coal; and I believe that it has been estimated that an engine uses fifty per cent. less coal in running light than she does in pulling an ordinary train; so that you can draw your own deductions regarding that.

I would say in regard to another point in connection with the compound engine, what I believe to be a fact, that in order to get the greatest success with a compound engine as compared with a simple engine, it is necessary to work it to its maximum capacity, and that is why we get the best service on freight. We took the first compound engine into Canada under bond, for the express purpose of testing her against our common seventeen and eighteen inch engines in freight service. I do not like to say what results we did get, because it might seem extravagant, and I will let that matter rest. But I will say that so far as our ordinary service goes, I think we can safely claim from fifteen to twenty per cent. of economy. At the highest rates of speed I should not care to put myself on record that there was a direct saving of twenty per cent., though others claim that—the men who are running the engine make the claim. But I understand that in order to bring these facts before this meeting they need to be carefully stated.

Mr. Lauder moved that the discussion be closed.

THE PRESIDENT—Gentlemen, the question is on the dropping of the discussion on this subject. Are you ready for the question?

The motion was carried.

Mr. Quackenbush read the report of the Committee on the Purification and Softening of Feed Water:

REPORT ON PURIFICATION OR SOFTENING OF FEED WATER.

Your Committee on this subject, through the medium of a circular, propounded the following questions to members of this Association:

First, Have you had any experience with mechanical devices, if so, with what results?

Second, Have you tried chemicals, and with what results?

Third, Have you found practical, and do you recommend for use, any of the mechanical or chemical devices for purifying water?

To these circulars we received replies from eighty-eight persons, thirty-one of whom had no experience whatever in water

purification. A large percentage of the number were operating engines where feed water was comparatively pure.

Five reported having used the Hackney Mechanical Device, but all found it unsatisfactory and discarded it. It was the opinion of some that this device was of some benefit in muddy, soft water, but no good in hard lime water.

Four reported as having experimented quite largely with the Fields Mechanical Device. Two found it to be of little value, as it could handle but a small percentage of the impurities of the feed water, and became choked with lime. They report adversely to practice of feeding water into boilers above high water line, which is necessary with this device. Two report this device as keeping a percentage of scale accumulations from flues, and preventing mud from accumulating on crown sheets, also decrease the number of times washed out. Still have device in use on few engines.

Nine had used the Smith Mechanical Device, which is something after the principle of the Fields Device, but of less capacity, and when operated in hard water, the report was unanimous that the device failed on account of being coated with lime and necessitated removal. Where water was muddy and not hard, it did fairly well, and decreased number of washings out. This device had, without exception, been discarded.

One had used a mechanical device from Detroit, Mich. which proved useless.

One is using the Mattoon Mechanical Boiler Cleaner on eighteen locomotives, and reports good results—feed water muddy and foams badly—with this device the foaming is overcome and can run engines three or four times as long between washings. One reports experience with same device without good results in alkali waters.

One had used the Oberchain Device without any satisfaction.

One used the Rice Heater, but accomplished nothing.

Two report using the Quackenbush Device, which gave some good results in muddy, soft water, but failed in hard water, becoming filled up with lime, and was discarded.

Five report now using the Barnes Mechanical Device with

good results. As compared with other devices, the capacity is such that it disposes of the heavier solids and keeps crown sheets clean and reduces greatly the accumulations in boiler and water leg. The reports are unanimous in voicing the merits of this device for any and all classes of water. As a heater and circulator its capacities seem unquestioned.

Your Committee has no description of all of the foregoing-named devices, but presume the members of the Association have knowledge of their construction, or can secure same from representatives of the device at this meeting.

Four report having used several mechanical devices, but received no beneficial results—kinds of devices not specified.

One recommended Shaw's plan of heating water (the originator of the device), which will no doubt be explained by him to this Convention. Mr. Shaw adds that water heated to 270 degrees Fahrenheit the solids will be precipitated, and if separate from boiler, scale will not form in boiler.

Twenty-nine report having tried numerous kinds of chemicals and compounds, but all state that no good results were obtained, and in many instances harm resulted when tests were made in locomotive boilers. Several testify as to good results from use of compounds in stationary boilers, but where the best showing is made, in the matter of keeping boilers clean, the expense for compounds exceeded the cost of refitting flues and cleaning boilers.

Two report having the National Boiler Compound in use. One condemns it, and the other reports fair results.

One reports having used a compound in brick shape, manufactured in Cleveland, which gave beneficial results, but the expense was too great.

Three report using tri-sodium phosphates to some degree—one says with fair success in scale loosening. Two find no success worthy of note.

One uses the following combination for locomotive boilers under direction of test department, and reports very beneficial results: Soda ash, caustic soda, lamp black, sorghum molasses, water—according to the chemical analysis of the water in use.

One reports experimenting with boiled potatoes through which the feed water is passed. Not able to give results.

One had used Hunt's Compound with fair success, and was experimenting still further with same.

Two were using sal soda, and were pleased with results in the prevention of scale formation.

Three had used litofuge, but could not recommend it.

One had used Lord's Compound, and the results were flattering, although not fully as represented.

One used Downey's Eucalyptus, but condemned it.

One used Winans' Incrustation Preventor, but gained nothing.

Proprietors of Chicago Vegetable Compound file letters from numerous stationary plant operators, recommending their production, but no testimony from locomotive men. The stationary men speak in highest terms of the merit of this compound.

Four recommend crude oil for prevention of scale in stationary boilers and to loosen scale in locomotive boilers.

Three recommend kerosene, but add it causes locomotive boilers to foam.

Four recommend filtering the water, or placing large tanks or reservoirs to catch supply of rain water, as the only complete remedy.

One is contemplating placing copper tubes to which a large percentage of foreign matter will not adhere, as the most economical action to take.

One has experimented with magnetic device placed in tank, but condemns it.

To sum up the information, your Committee gleans the fact that up to the present writing the efforts to purify the foul water and soften the hard waters, especially for locomotive boilers, have proved unavailing, and there is still much room for experiments in this direction. The sentiment of those who have expressed themselves is in favor of a mechanical device, as against the use of chemicals or compounds. Your Committee has not the information at hand that would warrant the recommendation of any device, but directs attention to the Barnes Mechanical Device, which, from a mechanical standpoint and the evidence before us, warrants us in taking this action.

The evidence is preponderant, and almost unanimous against the use of chemicals or compounds, while with the use of oils there is ever danger unless the greatest of care is exercised in placing it in boilers, as it cannot be surmised what mischief it is working by adhering to crown sheets or other parts coming in contact with the fire. Your Committee is skeptical on this point, having personal knowledge of the damage arising from such practices.

This being the first report on water purification presented before this Convention, we hope for a full and free discussion on the subject.

W. T. SMALL,
HARVEY MIDDLETON,
A. W. QUACKENBUSH,
J. B. BARNES,
J. W. HILL.
Committee.

DISCUSSION ON PURIFICATION OF FEED WATER.

On motion, the report was received.

MR. GIBBS—From the Committee's report it would seem that the purification of water in locomotives is in a very discouraging shape. I have paid a great deal of attention to the subject, and I do not look on it in that light. There are certain classes of water which we can purify readily without any damage to the locomotive itself, and without great cost—certainly not at a cost in a degree comparable to the cost of repairs to boilers that do not use purification methods. The two classes of waters I speak of are the incrusting waters and the alkali waters. The incrusting waters we do purify on our road by the use of chemical compounds. I do not mean by that that we use any substance which is corrosive in its action. That would seem to be the popular idea of a chemical, but this does not corrode anything. We are using a mixture of caustic and soda ash. There is no secret as to the mixture and no restriction as to its use. That is added to the water and acts on the lime salt solution in such a way that the latter is precipitated in the form of loose mud, which does not crystalize or bake hard, and the boiler is blown out when it is hot. Any water which contains less than 25 or 30 grains of lime salts to the gallon can be completely purified by this method, and leave only a moderate amount of alkali in solution. By the use of this compound, of course, we had a class of salts that caused foaming; but we determined by experiment that

anything under 50 or 60 grains to the gallon would not give any trouble to the engineer. We keep on adding the compound until it is concentrated to that extent in the boiler. Then the engine is blown out, sometimes on the road, but generally regularly in the round house. We have an engine built by ourselves which has now been run 150,000 miles and there has not been spent 50 cents on the boiler. It is a radial stay boiler, but I do not attribute this result at all to the construction of the boiler. This compound cost us last year, as I figure, about $\frac{2}{100}$ of a cent per engine mile. The total cost on the road was about $5,500, and the total saving in our coal bill of one per cent. would have amounted to $20,000. It seems to me, if it did any good at all, that one cent for fifty miles run is a small sum for obtaining perfectly clean boilers.

Mr. Boon—Some years ago there was a committee appointed for examining the question of the incrustation of boilers and impurity of water, and they spent considerable time in investigating the matter. Of the last committee I think H. A. Towne was Chairman. The result of their investigation was that the best compound to put in a boiler was pure water, and that that was the only way that the committee could discover to prevent incrustation. It has happened to me to have considerable experience on roads with bad water. There have been a number of mechanical devices and a number of compounds that we have tried. The first we tried was an electrical device. The idea was to make something that would throw all the incrustation scale off. The machines were connected with a copper wire. The result was that the copper got so full of scale and so heavy that the machine broke all to pieces. The next machine was a separator with a heater. We found it very expensive to run the heater, but the result was the heater got full of scale and blew up. The next thing was a plan to clear the water in the boiler. The theory was very beautiful but it did not work out properly. The theory was, that all impurities remained on the surface of the water. The water would be drawn through different pans arranged at different levels of the boiler. All impurity would be drawn through these pans and blown out. It worked very successfully apparently, but the result was the pipe stopped up with incrustation, the pans got full of scale and we discovered the result when we had to put a patch on the crown sheet. The fact is not to be lost sight of, in the first place, that a locomotive uses an enormous amount of water, and, in the second place, there is such a surprising difference in the composition of water. On 280 miles of road we had all the water analyzed and found there were 52 different kinds of water. Now, if a chemist would make a compound that would help us on one of those waters, on the next water it would make a worse scale. We employed a chemist to go through the whole thing, and the result was, after spending a good deal of time and money, the report was made that there was no compound in existence that would take that scale. After the scale is once formed it is stone. I have not met a chemist who could take a piece of that scale and dissolve it. You simply might as well take a piece of rock. From

my experience I consider that about the very poorest investment a railroad company can make is to put in a compound or mechanical device for cleaning boilers. There is no such thing in existence. We do not know what may come, but it has not been a success, so far as my experience has gone.

THE PRESIDENT—Is there any further discussion? If not a motion will be made to close the discussion.

On motion, the discussion was closed.

STATUS OF THE CAR COUPLER QUESTION.

THE PRESIDENT—The next business will be the Present Status of the Car Coupling question, which will be introduced by Mr. Hickey.

MR. HICKEY—I desire to apologize to the Convention for appearing before you a second time and having no written report on this important question of couplers. The question is a very important one and all our people have recognized that it is so. But I must say for the Committee that they have been unable to see their way clear to make a report that would be of any consequence to the Association, and their unwillingness to make a report that would not stand the test of time, is my excuse for not making a report on the coupler.

I will say, however, that from the replies that have been received, there is a general tendency and a general desire and feeling amongst our members that the link and pin as a coupler for freight cars should go; that it should be eliminated from the service as soon as possible. That seems to run through all the letters that I have received in connection with this subject.

There is another feeling that they express decidedly—that the coupler for freight cars should have an automatic feature. The automatic feature, they say, is demanded? They must have it. And before a man is willing to express himself on that, he says he must see an automatic coupler properly constructed and placed before the country.

The next point is, they say, that the coupler, as at present constructed, is somewhat dangerous from this fact, that should it break loose from its rear connections it is liable to be thrown on the track, and from its great dimensions it is liable to ditch the train. As to that, of course, you can all judge. They say that that danger should be eliminated.

In the communications we have also noticed a great desire on the part of the members of the Association to attach to the rear of tenders a close coupling or something to do away with a link and pin. But, as I stated, they want to see the automatic features of that coupler.

MR. SPRAGUE—I move that the verbal report be accepted and the committee continued for another year.

MR. SWANSTON—My understanding at the last meeting was that the line of investigation that the Committee were to follow was, to ascertain whether in the opinion of this Association the vertical plane coupler was the correct kind to follow in bringing about a perfectly automatic coupler. I understand that

some of the New England people are very much opposed to this, and my idea was that it was necessary for us to give an expression of some kind that would indicate whether that was the correct line—not as to whether it is a perfect coupler, or anything of that sort, but is it the proper line to follow in bringing about a perfect coupler? I do not wish to give an opinion on that subject, but I think that is the subject that we ought to handle.

THE PRESIDENT—The Secretary will read a motion from Mr. Garstang.

The Secretary read the following motion:

"I move that it is the sense of this Convention, that the use of the vertical plane coupler is a move in the direction of progress, and that the Committee be continued with power to represent this Association before the combined Board of Railroad Interstate Commerce Commissioners.

The motion was carried.

THE PRESIDENT—The report is before you, gentlemen, for discussion, if you wish to talk upon it.

MR. GIBBS—Does that dispose of the subject of vertical plane couplers?

THE PRESIDENT—No, sir; it is before the Convention for discussion.

MR. GIBBS—I understood the original intention was to give a complimentary vote on the action of the Car Builders in adopting that as the standard coupler—whether we could endorse it as a mechanical device.

THE PRESIDENT—I think this motion endorses it all right.

I think that some action is necessary, for the simple reason that the Railroad Commissioners of this country are acting very urgently in the matter, and it is due them from this Association to have some kind of an expression of the views of members.

MR. SWANSTON—I understand that the adoption of that resolution commits this Association to the vertical plane coupler as the proper line for investigation.

THE PRESIDENT—The adoption of the motion says it is a move in the right direction.

MR. SWANSTON—It is a move in the right direction—that is, that the vertical plane coupler is the right direction for an automatic coupler.

THE PRESIDENT—That would be the sense of that motion, I think.

On motion, the discussion was closed.

THE PRESIDENT—We will now take up the reading of the report on examination of locomotive engineers and firemen.

MR. POMEROY read the following report:

EXAMINATION OF ENGINEERS AND FIREMEN.

The Committee appointed to investigate the subject of examination of locomotive engineers and firemen on their duties relating to the use of fuel, care of the locomotive and ability to

deal with disorders or disability of machinery, to what extent practiced, and best plan for conducting the examination, sent out the following questions:

No. 1. Do you examine engineers employed from other roads on anything except time-card rules? If so, what plan do you pursue, and of what does the examination consist?

No. 2. Do you examine firemen candidates for promotion? If so, what line of examination is followed?

No. 3. In hiring men for firemen, what age do you consider the limit past the age of twenty-one years?

No. 4. Do you advise the first year in service, as firemen, be on switch engine?

No. 5. What do you consider the shortest time a fireman should serve in that branch of service before he is allowed examination for promotion to engineer? If fireman fails in examination, how do you deal with him?

To these questions your Committee has received fifty replies, fairly representing the best practice in the country; and by first presenting an analysis of these answers the concensus of the practical experience of the country will be shown, and, second, some recommendations based on the general subject. By so doing your Committee trusts it has thus fulfilled its duty to the Association on this important subject.

FIRST.

Q. 1. (a) When possible, such as old roads, trunk-lines, etc., it is not considered best to hire engineers, as such, from other roads, but to make or educate their own engineers from the ranks, and by so doing have men that are better adapted to the requirements of the particular service required, a better opportunity is afforded for more intimate and satisfactory knowledge as to the character of the men, and does not place any hindrance to the best incentives and inducements for men in the ranks who are looking and working toward the higher positions.

(b) But when such as new roads and isolated systems it is

not possible to educate or make all their own engineers, it is deemed best to give applicant same examination as to firemen candidates for promotion; in addition to this have to furnish satisfactory evidence of character and disposition from the roads where the applicant has been employed.

Q. 2. Except in a very few cases, many general replies have been given to this question, stating that applicants for promotion were questioned and carefully examined, but not stating any particular form, merely citing questions that would illustrate the general form or method used. The most elaborate plan handed in is that of Thomas Walsh, H. & St. L. Div. of L. & N., who states that the applicant is handed a list of questions, answers to which must be written in the presence of the examiner, and in addition the applicant is questioned fully on each question. If the answers are satisfactory the applicant takes the list of questions and is again examined by four of the oldest engineers, who sign the paper recommending the applicant. The applicant brings the list so certified to the master mechanic, who places same on file in his office. The master mechanic then gives the applicant a letter to the trainmaster, stating the extent and nature of previous examination, with the request that the applicant is ready for examination on Time Card Rules; if this examination is satisfactory the trainmaster gives a certificate to this effect. The applicant, armed with the certificate from master mechanic and trainmaster, presents himself to the Superintendent for inquiry as to record, character, etc. If this proves satisfactory the Superintendent signs the certificate; armed with these indorsements, the applicant is then furnished with proper credentials. Quite a complete form of questions was furnished by the A., T. & S. F.

The subject is not complete without directing your attention to the set of questions arranged by our Secretary, Mr. Angus Sinclair, in his well-known book on Locomotive, Engine Running and Management, because this list is carefully compiled and edited from a large mass of material coming from all parts of the country, to which much care has been given, with a view of covering pretty thoroughly the whole field or range of sub-

jects desirable for use in framing a particular or standard plan for examination of engineers and firemen.

Q. 3. The majority favor as a limit past the age of twenty-one years, twenty-eight years.

Q. 4. Twenty-five out of forty-seven favor first year's service as firemen to be on a switch engine.

Q. 5. The almost unanimous opinion is that three years is the shortest time a fireman should serve before being allowed examination for promotion as engineer, and it is quite the general opinion that applicant should be given one or even two additional opportunities, being set back on the list if he fails to pass examination for promotion, and all are quite agreed that if he fails on these he should be dropped from this branch of the service entirely.

SECOND.

A great deal has been said against having fixed sets of questions for use in examination of applicants; that the men would learn the answers to the questions, etc., and thereby defeat the object or purpose of the examiner. Now, it seems to your Committee that this objection is more apparent than real, for the examiner is not compelled to rigidly adhere to the set questions, but is at liberty to vary them as the circumstances demand; and as to the applicant committing the answers to the questions, or getting helped by the others, etc., is this an objection? The bare fact of the applicant so applying himself as to commit the answers is in itself a great point gained, and the examiner can readily determine whether the applicant has an intelligent conception of the matter involved in these questions or answers.

A great many of the forms of questions furnished from time to time are so elaborate or intricate that an expert mechanical engineer, or even master mechanic, would make sorry work with them. The idea of the questions is not to puzzle or trip the applicant, but to determine if he has sufficient knowledge of the machine he is to have in his care to satisfy the requirements of service.

The idea of progressive examinations as advanced by Mr. John A. Hill, associate member, is so *apropos*, and withal based

on such practical and common-sense grounds, that your Committee cannot refrain from presenting a brief synopsis of same in connection with this report.

(*a*) Explanatory.—So much of the examination of firemen for promotion is unsatisfactory on account of there being no proper system of training, and there is withal so much uncertainty as to what a man really knows, even after he has passed an examination, that the author proposes using a series of progressive examinations to insure good material to start with, and aid and assist the firemen to learn the proper things first, and provide a screen to prevent the advancement of incompetents.

The way to secure a good class of engineers:

First—Select good, clean material, inspect for culls, and have some quick and fairly accurate method of testing for such defects as would prevent the candidate from ultimately becoming a first-class engineer.

Second—Provide the opportunity and means, or at least point out the way to the student, to learn the rudiments of his business; first, teach him how to fire before he goes head over heels into valve motion.

Third—Provide an incentive to the learning of the right part first, and establish a point at which no progress or any other defect in the candidate for advancement will terminate the apprenticeship. Thus, officers can provide a system of periodical examination of firemen, and advance them step by step until they become proficient enginemen, and abandon the usual rule of putting a conglomerate gang of men on locomotives, letting them fire a term of years, and select the oldest for examination, only to find he is not posted and generally defective.

The progressive plan provides in the preliminary examination a gauge for measuring the character and mental status of the candidate and probable availability for purposes desired.

The first examination occurs after one year's service; the candidates' record and character inquired into and the questions propounded of an elementary order to determine the candidates' foundation work. Especial attention given to the proper understanding of signals.

The second embraces the subject of fuels, combustion, boilers and the duties of firemen.

The third examination occurs after the third year of service, and is a thorough one on the mechanism of the engine, brakes, etc., the examiner requiring a remedy or cure for every conceivable disorder or disability to the machinery and complete enough to warrant promotion, upon presenting a certificate of examination on train and time card rules from the Transportation Department.

If the candidate fails to pass this examination, he is apprised in detail where he is weak, and a chance afforded of posting himself on these defects and another opportunity given, for with progressive examinations there can be no objection to the "oldest man coming first."

The early examinations are merely to secure the proper material, and then put the young fireman in the way of himself getting hold of the right kind of information; advise him, guide him, and get him in the way of thinking and reasoning out things himself. He is led to study certain important phases of railroading at a time when he needs information on these subjects most, and those who are inclined to lag are spurred on by the thought of the next examination (here follow questions illustrating the form or type of questions proposed). Then follow suggestions—first to the examiner, and second, to the applicant—somewhat on the following lines:

(*a*) To the Examiner:

Bear in mind the experience of the man being examined. Do not think for a moment that your mission is to humble him, to "catch" him, to impress upon his mind how densely ignorant he is and what a store of knowledge you possess. Your real mission, especially in the examination after the first and second years of service, is to find out the progress made in certain lines, and guide the apprentice in the right direction, showing him what it is especially necessary for him to know, and giving him advice how to gain the desired information. Be impartial, patient and just, and, above all, avoid making yourself a bugbear to those to whom you are supposed to be a leader and

guide. In final examination, if possible, go with applicant to a locomotive under steam and propose your breakdown problems, rather than have him come to your office—the man will feel more at home and give more intelligent answers.

(*b*) To Applicant:

Suppose you have passed your preliminary examinations, been given a book of rules, and examination book and have fired a year. Be sure, before you go to examination officer, that you know what you are going for, and are at least thoroughly conversant with all signals in use on the road, and know something about combustion. Be orderly and cleanly, and go to examination fearlessly—the examiner can't hang you. If there is any subject that you cannot settle on the true solution of, ask those above you, even the examiner. Remember that the exact questions here shown will not be asked, so that it will do no particular good to commit answers. What you want is a fair practical knowledge of the subject; then you can answer any reasonable question upon it. Don't try to post up for examination day—get posted and stay so. Remember not only your life, but the lives of others depend upon your knowledge of your business, especially about signals and train rights.

Here follows a statement of the qualifications of applicant and a blank form of application, also a list of questions and answers and general letter of advice giving such suggestions as best will direct the thinking, study and demeanor of the applicant who is working for the future and advancement in his profession.

The plan covers the whole field from the preliminary to the final examination for promotion, advancing step by step, and is well worthy of careful study.

W. H. THOMAS,
JOHN PLAYER,
F. D. CASANAVE,
J. W. LUTTRELL,
L. R. POMEROY,
Committee.

On motion of Mr. Sprague the report was accepted.

No discussion was elicited.

Secretary Sinclair next read the report of the Committee on

OPERATING LOCOMOTIVES WITH DIFFERENT CREWS.

Your Committee appointed to investigate the subject of operating locomotives with different crews, begs leave to report that to a circular asking information on the subject under consideration we have received 38 replies.

Of these, 21 report that they are operating locomotives with more than one crew, and 17 that they do not, as a rule, but 10 of these report that they double-crew part of the year. Twenty-nine express a decided preference for double-crewing over that of pooling, while six only prefer the pooling or chain-ganging system.

Those who double-crew or pool make various statements on the amount of extra power they would require if obliged to assign engines to regular crews, and not require the men to run over 15 hours out of the 24, the lowest being 10 to 15 per cent., and the highest 50 per cent.

Reported costs of running repairs for pooled engines on 10 roads who quote vary from 2.47 cents to 8.01 cents per mile; the others report that they do not keep record of pooled engines separate from those having regular crews.

The advantages of operating locomotives with more than one crew are that it saves a large investment of capital in power, decreases the amount of fuel wasted in housing, banking fires and restarting them, and saves round-house room and fuel and plant for warming them in severe weather; where there are an unequal number of trains in opposite directions, the pool system gives the men exactly equal hours of rest and equal work. By the double crew system almost as much service can be secured as by the pool system, but not as even chances for the men.

The greatest disadvantages of the pool or chain-gang system is that it relieves the engineers of the sense of responsibility;

they lose all interest in the care and maintenance of the engines, and in consequence less miles are made between overhaulings than where the men try to maintain the power. It is almost impossible with any double-crewing system now in vogue to fix the responsibility for the results of misuse or carelessness, such as cut journals, valves, etc. It is difficult for the firemen to learn the peculiarities of steaming of the different engines. The engines are not properly cleaned, and no incentive is offered to the men to be economical in the use of fuel or supplies. The inspection and cleaning usually attended to by regular crews is in pooling an extra expense.

The double-crew plan leaves the care of the engine between two crews, and the entire sense of responsibility is not lost, but it is a very difficult matter to arrange the runs, especially on freight, so that the division of hours of labor and rest are equal among the men. And the details of arranging and changing runs are very annoying and unsatisfactory.

It is the plan on the C., M. & St. P. to assign regular crews, but not allow men to make over a certain number of days per month, letting the extra crews take the engines out periodically to relieve regular crews for a round trip.

On the C., B. & Q. when business commences to overtax the power it is the custom to "pool" or chain-gang enough engines to operate one division and distribute the extra power to the other division to relieve the pressure.

The motive power officials of one or two roads express themselves as satisfied with pooling, but all the others say they pool or double-crew only because they have not enough power to do otherwise.

As each one of you will have to meet the exigencies of your own particular service and equipment, it would be worse than useless for this Committee to recommend you a course of action for or against using locomotives with more than one crew; you will certainly use the least possible number of crews to obtain a maximum mileage.

The tendency of modern operating is turned toward doing the most business with the least investment for power possible, and it is more than likely that none of the large lines will own

engines enough to man each with a single crew and do the work.

Your Committee is led to believe that pooling can only meet with success where particular attention is paid to the inspection and repairs; in fact, where they make special provision to care for the engines, as they do on the P. R. R. No road can hope even for comparative success, handling the work as they would where engines had their regular crews.

In passenger service your Committee believe that the double-crew plan is better than the pool system; the runs can be more evenly distributed, and the double-crews do not lose their sense of responsibility or relax their care of fuel or stores.

In freight service it is a very difficult matter to arrange the runs for double-crewing, and where many "extras" are run; and the seniority of engineers call for the best runs, it is well nigh impossible.

Where pooling is found necessary, even temporarily, your Committee are of the opinion that better results will be secured if extra wipers and cleaners are put on to clean all engines fairly well in a few minutes while the fire is being cleaned, the tank and sand box filled and the engineers oiling around. Hostlers should be provided at terminals and engine taken to a track where all this work can be done at once; at the same time the hostler and his helper should take off the oil and clothes boxes of the crew that brought the engine in, and put on the private boxes of the men who are to take her out; boxes specially designed for handling should be provided. The oil and supplies should be charged to the *crew* and not to the *engine;* this provides a check for wastefulness and is an incentive to be reasonably economical.

Blank reports should be furnished and each engineer be required to turn over one to an inspector on arrival; this, in addition to reporting the work necessary, should contain a few questions, that could be answered by "yes" or "no," that will show the general condition of the engine, how she steams, condition of brakes and whether or not the engineer considers her in condition for further service without repairs.

Inspectors should be provided at all changing points; these men should be selected from the most experienced and careful engineers, and no work should be done on an engine without the approval of the inspector.

W. W. REYNOLDS,
C. G. TURNER,
JOHN A. HILL.
Committee.

On motion the report was received.

THE PRESIDENT—The report is before you for discussion.

MR. SETCHEL—I move we adjourn, Mr. President.

THE PRESIDENT—Before adjourning I want to call your attention to the necessity of being on time at 9 o'clock.

The Convention then adjourned until the following day.

THIRD DAY.

The Convention was called to order at 10 o'clock.

DISCUSSION ON OPERATING LOCOMOTIVES WITH DIFFERENT CREWS.

THE PRESIDENT—Gentlemen, the first business in order this morning will be the discussion upon the paper read at our last session on operating locomotives with different crews. The matter is before you for discussion.

MR. JOHN A. HILL—The Committee cannot claim to recommend anything in that report to the members here. They have got to do whatever the requirements call for with the power that they have. Our only idea was to find out what way they could successfully chain-gang engines for a certain period of the year during the rush. The opinion, as generally expressed all over the country, is, that a large majority of the men favor double-crewing instead of chain-ganging, but those who do chain-gang and pay particular attention to inspecting and repairing their engines—pay more attention to that—believe that it is better than the double-crewing system. I do not believe it is possible to double crew engines or chain-gang them satisfactorily without making special provision for the inspection and repair of those engines. The great objection raised to the chain-gang system is that it takes the responsibility off the men, and nobody seems to care anything about the engine, and it is very wasteful of supplies and fuel. But I believe that if the fuel, oil and other supplies are charged to the crew instead of the engine that better results would be had and the sense of responsibility would not be less.

MR. PECK—I have double-crewed engines and also chain-ganged them. I find better results by double-crewing than by chain-ganging. In Winter time when business is very heavy, I assign crews to engines. I keep enough extra men so that I can relieve these men when they have had a sufficient number of hours. I have had better success that way than with chain-ganging, and keep the engines in better shape.

MR. SWANSTON—I think double-crewing is the best. I have some runs where we have six men to four engines. They are doing very well. They have been running about a year. I believe they are doing just as well to-day

as when they were running each man his own engine. I do not think it has added anything to the repairs. I do not think it has added anything to our expenses whatever. On other divisions we have eight engines doing what thirteen formerly did, but it is not working very satisfactorily there. The objection I have to it is the objection that the name has. I think the whole matter lies in continuing long enough to get over the prejudice men have against it. I think if that is once overcome that the system of chain-ganging or double-crewing would be all right.

THE PRESIDENT—From whom do you find the most objections, from the engineers or the firemen?

MR. SWANSTON—From the engineers, and the firemen also—all object.

MR. HILL—There is one word I want to say about this. Some of the objections raised are that the men do not do the work on the engines. Take it where there is a small road, and men that have been there for a while, and I do not doubt but that is a serious objection. But on a big road, my observation is that, the man who does the most work on his engine does his engine the most damage. When his engine comes in for general repairs you will find the driving boxes cut and the rods out of repair. While the man who gets his engine in very good shape and leaves her alone does all right. With the chain-gang system, if the master mechanic would take the engine into his own hands when rods, &c., need repairs, I believe that objection would be obviated entirely. Take fifty engineers and at least forty-five of them will do as much damage as they will do good in doing work on their engines. That is my observation as an engineer.

THE PRESIDENT—Mr. Barnett, what is your practice in Canada, please?

MR. BARNETT—Practically, man for engine.

THE PRESIDENT—A very successful practice, I believe.

Will Mr. George W. Cushing give his ideas of this matter?

MR. CUSHING—I do not know that I can enlighten the Association much upon the subject. But from my experience I find the best practice is to have a single crew for an engine where that is possible. Where the circumstances are such that you are obliged to utilize the engines to greater advantage in case of increased business, put them into chain-gangs, as they call it, or let them take their turns about and make such provision for the care of the engines as is necessary. In other words, do about as the Pennsylvania Road do in the care of their engines under similar circumstances.

THE PRESIDENT—I presume that the difficulty in double-crewing engines principally in this country is that we cannot get them around so that two crews can make time enough.

MR. HILL—It is almost impossible in freight service to make it even for the men.

MR. STEWART—I would state that the practice on the Fitchburg Road is to give each man an engine as far as possible. At certain times of the year we cannot do that. At the present time, for instance, we either have two

crews to an engine or each man has his own engine. By the first of October usually our business is in such a state that it is impossible to do that. Our engineers do not know when they come in what engines they will have to go out with. They simply look at the bulletin board and see their names marked and the number of their engine. We have a system of inspection whereby every engine that comes in the roundhouse is inspected by a man whose duty it is to do that. I also require the engineers to make a report of anything that wants to be done to their engine when they come in, in addition to this general inspection.

The question of increased expenses in running engines by the chain-gang system was taken up by us, and I can say that last Winter, when our business was very heavy, I made a correct estimate of the difference in the cost for fuel in running the engines by the chain-gang system or by double-crewing, and I was very much surprised to see what difference it was in the item of fuel. I presume you will all be surprised. I have been led to think that it would make a very great difference in our fuel account whether one man ran an engine all the time, or whether the engines were run promiscuously, but after making this test, which lasted six months, I found that the difference in the expense of fuel of one system over the other, was only one-half of one per cent. in favor of double-crewing the engines against each man running his own engine.

On motion of Mr. Swanston the discussion was closed.

THE PRESIDENT—The next business in order will be the reading of the report on Locomotives for Heavy Passenger and Freight train service.

SECRETARY SINCLAIR read the following report:

LOCOMOTIVES FOR HEAVY FAST FREIGHT AND PASSENGER SERVICE.

Your Committee on the Relative Merits of Ten-Wheel vs. Mogul Engines for fast freight or passenger service, would respectfully report that we have omitted consideration of the eight-wheel engine, inasmuch as no discussion on this point was called for. With an 18x12 inch cylinder the relation of weight, power and size of wheel was preëminently correct in a properly proportioned eight-wheel engine for all service not demanding more power than can be obtained with that type. Also the fact that we never heard it disputed that they met all requirements of safety, etc., fully as well as it could be done.

We took it for granted that the discussion would be entirely as to the comparative values of the ten-wheel and mogul type

when circumstances made it desirable to increase in power and weight beyond the eight-wheel engine. At this point there is a dividing line, which for the service under discussion nearly annuls the value of the mogul, because the weight as between an 18-inch engine and a 19 inch increases out of all proportion to the increased power, unless this power is obtained by decreasing the size of wheel, which is not desirable for the service named. For a 20-inch cylinder more weight will be obtained on three pairs of drivers than can be utilized with a 60-inch wheel, leaving a sufficient weight on each truck wheel, say 7,000 pounds, but preferably 8,000. Of course it is understood that this always contemplates the use of a wheel large enough for fast service without excessive wear as a necessity, and does not apply to proportioning freight engines for ordinary service. Considering it a fact that weight enough can be placed on the drivers to utilize all the power, then it resolves itself into a question of the most economical use of such power and weight. There has been nothing suggested either by others or our own observation, to indicate that the mogul has any advantage in following the line, either as to avoiding destruction of track or itself, although in our opinion, with the actual wheel base the same, the mogul is practically a shorter base, as, with the swinging of pony to one side, the guiding point is carried back under the engine to a point determined by the length of radius bar and angularity of links or hangers. For instance, a mogul equipped with radius bars worked out to usual formula and the truck hangers hung vertical, would not be guided by pony at all, except the slight friction in displacement, and the drivers would do all the guiding. On the other hand, with a very short bar and extreme angles, it would guide almost entirely by pony wheels. While the guiding point of the ten-wheeler is always at the center of the center pin, if rigid, you will see by the answers to circular that nearly all who have had experience consider this the proper manner to connect truck where blind tires are forward ; also that this arrangement of tires is preferred. This point we would like to hear thoroughly discussed. While we are satisfied that the rigid truck is perfectly safe, and that in

guiding around curves it is exactly right, such curves being supposed to be put up so as to guide on and off with the same action as when in full curve, there is no reason why we should provide for an easement at those points at the expense of an increase of guiding power at some other, as it takes exactly the same amount of such power to divert and control on the curve, whether expended on entering or at some time before or at leaving, and any amount of swing is sure to grind driving-wheel flanges. At the same time, observation of the action of very heavy engines of this class at high rates of speed has led us to a belief that there is a happy medium between two extremes which may be safely followed. While we do not think any swing is needed for curves, still we do think some benefit would be derived, and more especially on straight track, if the truck were allowed to accommodate itself to depressions and bad surface readily. Of course the wheels drop to the extent of the clearance below the box, but we think it would be well to allow the truck itself to follow in some degree without pulling the engine with it. This can be readily done without losing the benefit of the rigid truck, or rather without the defects of the general run of swing motions.

In this connection we wish to call attention to a fallacy that has been promulgated as a fact : *i. e.*, that a short hanger hung vertically has the same effect as a longer one set at angles. This is not correct, as, in the first place, a vertical hanger does not hold to a true center under any conditions, and an engine so hung will vibrate on straight track ; next, it has no guiding motion until too far out of center to be of any use. A pair of hangers hung vertically will raise the engine or depress the springs one-quarter inch only, when one and one-half inches out of center ; while the same length of hanger set at an angle of one and one-half inches, or three inches spread, will raise on the outside three-quarters of an inch, and the other one in dropping to a vertical will only drop one-quarter inch. Not only this, but they always hold to a true center until a force is applied equal in degree to the resistance of the angularity.

A majority are in favor of the ten-wheel engine for the service

under consideration. Still, there are some points of value given in regard to moguls even by those preferring the others, especially in lengths of radius bars. While but a few give the rigid-wheel base or entire base, those who do show them worked out by the usual formula or very nearly; still, the general impression appears to be that where the radius is shortened the guiding action is improved, and a division of flange wear as between truck and forward drivers is obtained. This is especially noticeable in one diagram showing three classes of engine, of which it is said the best results are from class 200, whose actual radius bar is 47 inches, while the formula would call for 64½ inches. The next best results were from class 400, whose actual radius was 49½ inches, as against 69½ called for.

The poorest showing was from class 300, whose actual measurement was 64½, as against 68.8 called for. Of the class 200, the report shows 80,000 miles without either truck or driving-wheel flanges cut.

To queries we have answers as follows:

Q. No. 1. Do you consider a ten-wheel engine preferable to the mogul type for heavy fast express train service? If so, why?

A. No. 1. Seventeen answer in the affirmative, one in the negative; two have not used ten-wheel engines in such service, both are using moguls, and prefer them for such curvatures as they have; one has ten-wheel but not satisfactory, recommends the eight-wheel as the only one to fill all requirements; one has ten-wheel, but has every confidence in the safety of the mogul; and five have no experience and offer no opinion.

Q. No. 2. Do you consider that the pony truck is equally as safe under all circumstances and conditions of track as a four-wheel truck, for fast express engines running at as high a rate of speed as sixty-five miles an hour?

A. No. 2. Two answer in the affirmative; twenty in the negative; three no opinion, and two answered in No. 1 as to the use of moguls.

Q. No. 3. What has been your experience as to flange wear on pony truck wheels of mogul engines, as compared with the truck wheels of ten-wheel engines?

A. No. 3 Six no difference; five no experience; seven greater in moguls (no percentage given); one greater in moguls with steel tires, no difference with chilled; one less on moguls than eight wheel; two greater on moguls 20 per cent.; and 2 to 1 in favor of ten-wheel.

Q. No. 4. Can you give the comparative mileage made to the one-sixteenth inch of wear, as between the truck wheels on mogul engines and ten-wheel engines. Also comparative flange wear on driving-wheel tires of same engines?

A. No. 4. One replies, 10,986 miles per one-sixteenth wear, but does not give diameter of wheels.

Q. No. 5. What style of radius bar do you use for mogul engines? How do you figure its length? and could you furnish drawings for mogul truck for use at coming Convention?

A. No. 5. Seven sent blue prints with which were two formulas, and two had wheel base given, one of which shows the length of bar to conform to the formula. The others, not having this data, could not compare. One describes diagram as follows: "To find the radius bar I set out a diagram of rigid wheel base on worst curve we have, and project the centre line of engine away beyond the truck axle, and then set the truck axle on the curve in such a position that if the center line of axle were produced it would cut the center of radius of curve; then draw a line from center of truck wheels at right angles to the center line of truck axle until it cuts the center line of engine; the distance from the points of intersection of the two lines is the length of radius bar." While one gives the three diagrams of bases and lengths of radial bars as referred to before.

FORMULA FOR CALCULATING RADIAL BARS.

No. 1. When R = rigid wheel base,

D = distance of front flanged driver to center of truck,

X = length of radius bar.

$$X = \frac{DR + D^2}{R + 2D}$$

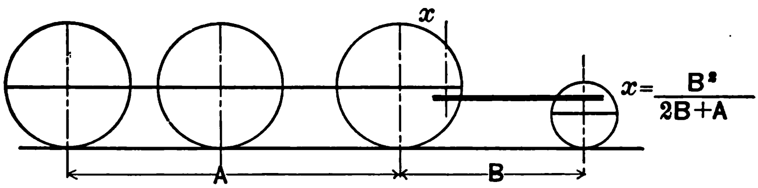


Fig. 10.

Q. No. 6. What proportion of weight do you think should be on drivers and pony trucks?

A. No. 6. These answers run about a regular scale from four to one or one-fifth on truck, to seven to one or one-eighth on truck with all the intermediates, while three say at least 14,000 pounds on a pony or 7,000 pounds per wheel.

Q. No. 7. What is the limit of weight, in your opinion, one driver should take?

A. No. 7. The general answer is 16,000 for rail under 60 pounds and 18,000 for rail above that weight.

Q. No. 8. What is the least weight you would recommend for a four-wheel truck?

A. No. 8. This is answered by percentages running from 20 to 33 per cent., and in direct weights running from 7,000 to 8,000 pounds per wheel.

Q. No. 9. On ten-wheel engines, would you recommend the blind tire forward or in the center?

A. No. 9. Fifteen in favor of putting blind tire forward, three in the center, and one would flange all the wheels.

Q. No. 10. In case of blind tire being in front, would you recommend a swing-motion truck?

A. No. 10. Eighteen recommend rigid truck, one swing motion, and three very light swing.

The question of economy of operating engines of such proportions as to necessitate either a ten-wheel or mogul engine as against lighter power and more trains is an open one, on which an intelligent opinion can be given only after time enough has been given to observe the expense of maintaining both rolling

stock and track. Even then the testimony will be conflicting. We will ask to be excused from offering an opinion on the subject at the present time. That we speak advisedly as to the prospects of conflict of opinion in this matter, we will state that the experience of one of your committee, on different divisions of the same system, would justify him in having either of two opposite opinions had his observation been confined to only one division. Of five engines identically the same, four were put at work in heavy service where a high rate of speed had to be maintained constantly; while the other was put where trains were not more than seventy-five per cent. as heavy, the average speed being about ten per cent. less, other conditions about the same. The four first spoken of soon showed signs of distress, while there was nothing to indicate that the other was any more strained than an average eight-wheel engine would be doing the same work, as she ran alternately on the same trains with three 18x24 eight-wheelers. The distress appeared to be altogether in side motion, such as loosening pads on frames and boiler, and other parts affected by side thrust. We have no information as to effect on track.

While ten-wheel and mogul engines have been in use for years, yet they have not been used for fast freight or passenger service long enough to afford a great deal of information from actual experience, and many of the answers are given on general principles.

As a summary we would say, from all information furnished, we gather that the preference is for the ten-wheel engine as against the mogul, on account of its being practically the same as an eight-wheel, the forward drivers being simply burden bearers, and leaving wheel bases actually the same. Next, because the distribution of weight is such that, while gaining sufficient adhesion to utilize all the power, there is not an excessive weight on either wheel. For example, an engine properly proportioned for 20x24 inch cylinders at high speed will weigh about 130,000 pounds. On a ten wheeler this would give 32,000 on truck and 98,000 on drivers, while with a mogul we would scarcely put more than 20,000 on a pony, leaving 110,000 or, per-

haps deducting 2,000 for difference in construction, 108,000 to divide on six drivers. While this weight would not perhaps be destructive to track, it is more so than the 16,333, besides being useless. Again, the majority claim greater safety on crooked roads for ten-wheel engines.

In conclusion, the Committee would say that the relative economy of these engines in fast service as against eight-wheel could better be answered in the future than at present with the limited actual experience we now have.

PULASKI LEEDS,
JAMES MEEHAN,
E. M. ROBERTS,
C. E. SMART,
W. A. SMITH,
Committee.

DISCUSSION ON TEN-WHEEL AND MOGUL LOCOMOTIVES.

On motion of Mr. Sprague the report was received.

THE PRESIDENT—Mr. Leeds, I believe you are chairman of this committee. Will you open the subject?

MR. LEEDS—I think we have said about all we can say on the subject. It is only on points of controversy that may be brought up that I see any chance to go further with it.

MR. BARNES—I would like to ask a question as to the meaning of the paragraph where it states that for a twenty inch cylinder more weight will be obtained on three pairs of drivers than could be utilized with a sixty inch wheel. I would like to know why such a condition is imposed? Why is it that with a twenty inch cylinder more weight is obtained?

MR. LEEDS—What we claim is that about 90,000 pounds is all you can utilize in a 20x24 inch cylinder and a 60 inch wheel. That is, that you have more tractive force than you have power. We did not consider that we should go below a 60 inch wheel with that class of engines.

MR. BARNES—That hardly explains why the weight is necessarily obtained with that cylinder. There is a statement here regarding the radius bars and swing links, that should have attention. It says that: "The truck hangers hung vertically, would not be guided by pony at all except the slight friction in displacement, and the drivers would do all the guiding." Now the fact is that with vertical swing links there is a tendency to return to the center immediately when the truck is displaced, and there is a decided guiding tendency when the hangers are hung vertically. When the hangers

are hung outward and the centre bearing is wide and flat, there is less guiding tendency at the start from the central position than when hung vertically, and there is more under the same condition when they are hung inclined inwardly at the bottom.

MR. LEEDS—I have very strong doubts that a vertical link will begin to resist side vibration nearly as much as those hung outward. In fact I know that it won't.

MR. VAUCLAIN—I have taken the trouble to construct models and carefully weigh the difference between vertical swing links and those set at an angle, and I can state that there is no appreciable difference except when you go to extremes ; no one would take it into consideration. I have made this model—a very elaborate one, put my weights to it, applied my strains, measured them accurately, and we have constructed probably four thousand engine trucks with vertical engine truck swing links, and we have yet to hear the first complaint.

MR. LEEDS spoke of trouble he had experienced from the side vibration of engines having vertical hangers for pony truck. In regard to tests with a model, with a small model you have got to have an excessive weight to make a clear demonstration of what it will do under service and over springs, and I do not think that anybody can say that a pendulum takes as much power to swing it from a perfect perpendicular as it does to raise it when it is inclined to an angle, and another one that the angles do not fall on one as it raises on the other. The consequence is that you have either got to compress the springs in your truck or raise the weight in your engine nearly three to one, with hangers set to an angle, as against two perpendicular hangers. Take hangers six inches long and hang them perfectly perpendicular, in swinging this perpendicular pendulum—the two of them—the angle formed between the raising link will be nearly one-quarter of an inch. By placing them on an angle of an inch and a half the outside one will raise three-quarters of an inch whilst the other is nearly dropping to a perpendicular or one-quarter of an inch. I will say further that on these same engines, put to work in December with a vertical link, in less than six months I had to turn them off on account of sharp flanges on the middle drivers, and the same engines with the angle hangers in the truck have run some time and shown no distress on their flanges.

MR. AUSTIN—I would like to ask Mr. Leeds what the relative lengths of those hangers were—whether the perpendicular hangers were the same length in the center as the angle hangers.

MR. LEEDS—They were the same hangers. I merely made a new casting and spread the holes in the center casting.

MR. AUSTIN—The fact of the matter is that it is not necessary to have your hangers on an angle in order to get a certain side resistance. If you make the links plumb and make them as much shorter as the perpendicular distance—say they are angular links either out or in—if you want to make

those links plumb you will get the same guiding effect exactly if you get the perpendicular distance, instead of the hypotheneuse of the triangle. Then you get exactly the same side resistance and influence of gravity as you would with this link set either in at the bottom or out at the bottom—it is exactly the same. Now the difference is, that if you hang the links plumb and make them of a length to suit them, you will guide without cocking up the bolster as it is with the links hanging out, or on the other side, as it is with the links hanging in. As you swing around the curve the most of the draft links will come on the outer wheels. Now if you hang your links plumb no matter where you are springing, you still keep the same thing on each journal.

MR. WEST—I would like to ask Mr. Austin if the same theory would apply to a passenger car truck.

MR. AUSTIN—I do not see why it would not.

MR. WEST—I know the experience is not the same with passenger car trucks. I know with the hangers spread they give much better results.

MR. LEEDS—For the last twelve or fourteen years. I was asked in the first place why we made our radial bars to a certain formula and I found that those that were working very nicely were not the accepted formula; whilst those that were working at all satisfactorily, were hung on an extremely angled hanger. I went to work and experimented on that hanger to see what the result would be and I could adjust the hangers so that in curving the wear was on truck flange entirely, I could divide it up between the truck flange and the forward driver—this is on a mogul of course—or I could make it cut on both the forward truck flange and the back flange of the driver. I am well satisfied that there is a great difference as to whether you hang on an angle which as soon as it begins to move takes the weight of your engine in consideration of its guiding power, or whether it swings as a pendulum with a very slight elevation and very little change in the weight that is on it.

MR. LAUDER—My observation and experience with mogul engines, covering a period of twenty years, leads me to precisely the same conclusions that Mr. Leeds expressed. Still, theoretically perhaps, the other view taken of it may be correct. In practice, so far as my observation has gone, the links hung vertically will usually allow the front driving wheel flanges to chafe and become sharp. I have seen mogul engines put out new and in a month the front flanges on the drivers would show signs of chafing, where the links on the truck were hung vertically. By simply changing them, as described by Mr. Leeds, spreading at the bottom, it has taken that chafing off of the tires and they run very satisfactorily. Whenever that is done, of course the guiding of the engine—the side thrust that must take place in guiding an engine around a curve is transferred to the truck wheel where it belongs. That is why the truck is put there. A great many may have noticed in mogul engines that steel truck wheels under the pony truck would chafe and get sharp. I always like to see that, because I know the truck then is doing its proper duty—guiding the engine. I want to qualify that a little. That might be produced by a radius

bar of an improper length ; but where there is no chafing whatever on the front guiding truck of a mogul engine, you may look for sharp flanges on the drivers. Now I apprehend that the reason why vertically hung links allow the chafing of the front flanges on the drives in some cases is because of their extreme sensitiveness. They will spring slightly—say half or three-quarters of an inch without material rising of the engine, and that rising of the engine is so slight that she springs that distance direct, and unless the engine is thoroughly well balanced and runs at the speed for which she is balanced, she will swing her front end. There is not anything to prevent that except the friction of the driving wheels on the rail. Now spread the bottom of the links, and it almost invariably stops that, showing that that does check the tendency to side vibration and consequently showing that it takes more power to move those links. In other words the links will have more power to swing the engine than they would if they were hung vertically. I do not think that among practical men there is any question about it.

Now with reference to the merits discussed in this report—the relative merits of ten-wheel and mogul engines for passenger service, it is somewhat a question of locality, largely a question of prejudice and very little a question of actual fact. They both do good work. The man who has started in with a mogul does not want to admit he has made a mistake. Consequently he will be very strenuous to maintain that the mogul is the best engine of the two. The other fellow will condemn the mogul and will say, "I don't like that truck; I will have a ten-wheeler." "Why don't you like that truck?" "Well I don't consider it safe." "Why? This is no new design of engine. It is an engine that has been for twenty or twenty-five years subject to all kinds of conditions and circumstances, narrow gauge, broad gauge, hills and valleys, crooked track and straight track, Have you ever in that twenty or twenty-five years that covers the life of the mogul locomotive known it to leave the track?" "No." "Then what leads you to suppose it is unsafe?" "Well, I would rather have the four-wheel truck." That is about the only reason I have ever heard given for using the ten-wheel engine rather than the mogul. For my own part I like the mogul. I do not quite agree with all the conclusions, especially in regard to the distribution of weight on a ten-wheeler. I think the distribution of weight is very much better on the mogul. In the first place you do not have to carry so much unnecessary weight on your truck. Now, if their conclusions are correct, 95,000 pounds, or whatever it may be, is ample for a decent weight. I think most of us will feel that we have got a total weight that is not excessive if it is properly distributed, and it is better to have a little surplus weight on our drivers to make up for a defective track and other contingencies that may arise, than to carry around from fourteen to fifteen tons of absolute dead weight on the track when seven or eight tons is all that is necessary to do the guiding of the engine. The ten-wheeler is really, as report says, the same as an eight-wheeler. All the conditions are the same —simply another wheel put in in front of the ordinary four pair of drivers and

connected up. I really never could see for what. I suppose the theory is that it takes a little of the weight off the other drivers. It does. But the ordinary ten-wheel engine has her weight distributed in rather a bad way. Yet the ten-wheel engine is very popular. I want to say this, we are largely influenced by fashion ; we want to keep in the swim, and we are apt to copy someone else who, we think, knows a little more than we do. Possibly some of you do not do that. But these things run in cycles. They get to be fashionable. I can remember when the ten-wheel engine was used thirty years ago—yes, thirty-five years ago. It gradually went out of use almost entirely. A few roads may have stuck to it for particular kinds of work. But practically the ten-wheel engine was superceded by different types of engines—mainly the mogul. I believed then, and I believe now, that that was a wise movement. Now someone has all at once discovered that the mogul engine is not worth anything ; that is, that she is unsafe. They cannot point out a case where she has shown it, and they want to go back to the ten-wheeler because they think the four wheel truck is safer than the mogul. They give no facts to back it up whatever. No one here will argue that the consolidation engine is unsafe or that it is not a desirable engine for freight. The consolidation engine is simply a mogul engine of a little larger growth, just as the ten-wheel engine is an eight-wheel engine of a little larger growth. In both cases the construction of the engine is precisely the same. There is only the additional pair of wheels. Has any one ever heard of a mogul or consolidation engine leaving the track by reason of any defect in the construction or principle? I never have. So that the prejudice existing against that type of engine on account of the pony truck, I think should be deprecated by every fair-minded man, because it has no force or effect whatever. [Applause.]

Mr. Barnes—Before this discussion closes I would like to set myself right in this matter. There seems to be no difference in opinion here between Mr. Austin and Mr. Leeds. Mr. Austin says if you want to get the same lateral resistance you want the hangers. I should think that was true. I would like to ask one further question—if the committee mean to say that any amount of swing in the engine truck is sure to grind the driving wheel flanges, and also do they mean to say they do not think that any swing is needed for curves?

Mr. Smith, Northwestern—I would like to ask how far it is thought advisable to reduce the weight of the truck on the ten-wheel engine. We have a large number in freight and passenger service and we carry fifty-five hundred pounds on the truck on each wheel, or in other words about 21,000 pounds on the truck.

Mr. West—I hope this Association will not go on record as advancing the idea that the pony truck under the mogul engine is unsafe. We are running mogul engines 55 miles an hour and I am sure ours is one of the crookedest roads in the country. I have never had a train leave the the track on account of the mogul engine.

Mr. Leeds—Is there anything in the report that indicates that the com-

mittee considers the mogul engine unsafe in any way? If there is, I wish to say that it is not the intention of the committee to question the safety of either mogul or consolidation. The only thing that I would like to call attention to is, that Mr. Lauder, I think, has got the idea that the weight on the mogul under any circumstances is better than on a ten-wheeler. Now we particularly call attention to the fact that we make the statement about the proper weight only when a 60-inch wheel or larger is used. Most assuredly, when you begin to get your wheels small enough, so that you can utilize the weight by getting the power, we then should go to a mogul engine in every instance, and I would say that I consider the mogul absolutely safe, and in fact I think a four-wheel engine truck is not anything else than a radial bar turned into a forward pair of wheels and a back pair that does but very little if any guidance.

THE PRESIDENT—I would say, for the information of the gentlemen, if they look at question No. 2 in the report here and the answer to it, they will find that twenty answer in the negative—that they do not consider a mogul engine safe for fast passenger service. That is not however recommended by the committee.

MR. LEEDS—You will notice also that we say that the most of them give their answers on general principles. They do not give anything to bear out their assertions as to why they do not consider it safe.

MR. SPRAGUE—It seems to me that of those twenty members there must be one or more here. If there are, I think they will only be doing their duty by letting us know why the mogul engine is unsafe.

MR. LAUDER—I should hate to have it thought that any member considers that locomotives running to-day are unsafe. I do not so read the report. In answer to the question as to whether they consider a mogul pony truck as safe as a four-wheel truck, they do not say they do not consider it safe. A thing may be safe, another may be safer, some other thing may come up that is still safer than any of them, and that is safest. I do not think that either of these gentlemen meant to convey the idea, in giving his reply, that a mogul engine is unsafe, because that is directly contrary to the facts of experience. For twenty years engines have been built and have gone into the scrap heap. Graveyards are full of mogul engines as well as other engines, so that it is not anything new that we are just experimenting with. I feel a little earnest about this, because for twenty years the country has been using mogul engines and all at once we find a class of men who say they are not safe. We must not go out to the world with such an idea, when it is contrary to the facts. These men do not take in the full meaning of what they say.

MR. WEST—I would like to call attention to the last part: "As a summary we would say from all information furnished we gather that the preference is for the ten-wheel engine as against the mogul, on account of it being practically the same as an eight-wheel." That is, a four-wheel truck in front—that leads our managers to believe that the ten-wheel engine is safer than the mogul. Why? "Because"—they say. That is a woman's reason.

MR. MEEHAN—I do not think it was the intention of the committee to convey the idea that a mogul was not safe for any service. On the system with which I am connected all the freight engines are moguls and consolidation engines. I believe, at the same time, for passenger service, that we should have the greatest factor of safety. It has been our experience that with a steel tire on a mogul engine we could not maintain it, which shows very conclusively that there is greater flange wear on a mogul engine than there is on a ten-wheel engine. Under these conditions we considered it was better to have a ten-wheeler where it was necessary to exceed 18x24 inch cylinders—to have a ten-wheeler for passenger service.

With regard to the angularity of the link, which was discussed here between Mr. Leeds and Mr. Austin, I never could see any particular difference. We have engines both ways. Our Baldwin engines are just as Mr. Austin described—vertical. But we have found that where we did not maintain the proper weight on the trucks that the front flange of the driving wheel would cut. Where the proper attention was given to screwing up the bolt, or holding the proper ratio of weight on the truck, we never found any difficulty with cutting our mogul engines. When we found it necessary, however, to get large engines for passenger service, we felt disposed to go to the ten-wheeler, believing that there was a greater factor of safety for a high rate of speed, not because we believed that the mogul was not safe. I prefer the mogul, for the simple reason that we can do the same work with a lighter engine. We do not carry the surplus weight that a ten-wheeler has to carry to do the same amount of work and we have always considered, for good freight service, that the mogul or consolidation engine was about as economical an engine as was used.

MR. SMART—Mr. Meehan has expressed my views. His views are so nearly like my own that I have very little to say. But I would like to call attention to the wording of this question: "Do you consider that the pony truck is equally as safe under all circumstances and conditions of track with a four-wheel truck for fast express engines running at as high a rate of speed as sixty-five miles an hour."

Now I advanced that question, and I do not understand that the Committee are responsible for the answers given to that. There is an element of safety in the four-wheel truck which is absent from the two-wheel truck. If it were not so, we should not be building six-wheel trucks for passenger coaches to-day. There is no question but that the greater number of coaches running to-day could be carried on a four-wheel truck with perfect safety. But isn't there a factor of safety in the six-wheel truck? I have known of a coach running some forty miles—running over bridges—with the center wheel off the track, one inside and the other outside, and the car went safely. Now the question is what would have been the result if it had been a four-wheel truck? I notice on the Lake Shore that there are some engines running to-day with a pony truck and two drivers coupled. Now why do they not continue that practice? Why was a four-wheel truck substituted in place of a pony truck?

Those are questions to be answered. As far as the mogul engine is concerned, I have no hesitation whatever in running a mogul engine at the rate of fifty miles an hour in heavy passenger service when it becomes necessary, and I do not have any fear of the results. I do not want to put myself on record as saying that I consider a mogul engine unsafe, and if it became necessary I should have no hesitation in running a mogul engine ahead of a passenger train. But I believe that the ten-wheel engine is preferable.

MR. LEEDS—I want to insist on Mr. Meehan finishing. In other words he has got some ten-wheel engines identically the same as the ones that have given me so much trouble, on account, as I claim, of the vertical link. I would like to ask if he did not use some other mode of getting over the cut flanges than I did. That is if he did not put his flanges on the forward drivers, if the result was not the same when he had the short vertical hangers.

MR. MEEHAN—I must say, Mr. President, that we put three ten-wheel passenger engines in service on the Cincinnati Southern Division—the two middle districts are very crooked—and we found that the blind wheels which were in front jumped the track. I commenced an investigation in the matter. The master mechanic at that point reported to me that he could not find anything wrong with the engine. I had her sent to Ludlow, and on close eximination found that there was considerable lateral motion between the hubs. A box of the engine truck broke: We immediately took up the lost motion and stopped it. They were enjoined in the future to keep a close examination and not allow the lost motion to occur before it could be taken up. But the second time it occurred, and I took the engine to the shop and changed the flange tires on the front. In the meantime the engine had a rigid truck. After we changed the flanged wheel on the front I was compelled to leave the rigid trucks under the engines until such time as I could arrange a swing motion to take their place and to take them in, one by one, until such time as we would have them changed. I found though that they ran elegantly with a rigid truck. We sent around a swing motion truck. The man was very anxious to hold his rigid truck. In making further investigation of the matter I came to the conclusion that I had made a mistake—that I should have left the rigid truck even with the flanged wheel.

Now we have another case similar to this on the Louisville Southern. There were two very heavy Rogers' engines placed in service on that road and I think they were in service about eight months when the road was turned over to the East Tennessee, Virginia & Georgia, and those two engines had flanges as thin as a knife blade. I took the engines in the shop. They also had the blind tire in front. I took the engines in the shop, turned off the flange, and had to turn down the tread of the wheel to get the flange, because there were portions of the flanges broken. We changed the flanged wheel to the front and our trouble ceased. The engines are doing splendidly. Those engines have got rigid trucks. I must say that I have not a particle of faith in a swing motion truck for a ten-wheeler, and I do not think that Mr. Leeds can get any

information from me on that particular point. The question was on the moguls, as I understand it—whether the vertical or the spread link was the best. As I said previously, I cannot give any information on that subject.

Mr. George Gibbs—The particular question under discussion would seem to be on the relative merits of the classes of engines for freight and passenger service. It seems that the discussion is narrowed down to the question of safety alone. There are other questions that could be taken into account, such as the relative cost of the maintenance of the two classes of engines. There are too many hundreds of mogul engines which have been running in all classes of service in this country for years, to raise any question of safety for that service. They are known to be safe when kept in good condition. But which engine can be kept in serviceable condition better and longer and easier and cheaper? From what has been brought out here to-day and from what we have seen in the papers for years past, the proper running of the mogul engine seems to depend on several delicate adjustments in the truck, especially the swing hangers and the length of the radius bars. As far as I have seen, nobody has come to any uniform rule in those respects. Now if that question of adjustment is easily arrived at, why haven't we arrived at it? We, on our road, have ten-wheel engines exclusively for fast freight service, and coming into our roundhouse there are some moguls of another road. I watched those pretty carefully. I do not know anything about the particular design of the engines, but they do cut the truck wheels badly. Now if those truck wheels run with sharp flanges, it would not seem to be a very safe condition for them to be kept in, and if that can be easily remedied, why hasn't it been remedied? We know that for a crooked road there must be no question of the perfect guiding of the front of the engine in entering curves. We know a four-wheel truck will do it satisfactorily and without very much wear. We also, it seems to me, would be justified in concluding that a two-wheel truck with sharp flanges would do it safely.

There is another question that I want to bring out—the relative difficulty of keeping those two classes of engines in good serviceable condition.

Mr. Setchel—Mr. President, I did not intend to say anything on this subject, but the matter has taken such a turn that I think it is liable to be quite misunderstood, It seems to me that the point aimed at by the committee was to ask which was the superior type of engine for passenger service, and the twenty men who answered, that under all circumstances they did not think that the mogul type was as safe as the ten-wheel engine, were honest in their convictions, and the attempt to ridicule the opinion of men, simply because they say they have never heard of an accident from a pony truck, is a little out of the way. You might turn the tables and ask the question: Did you ever hear of an accident from a four-wheel truck? and argue from that that the pony truck was the best. We keep our tracks in these days in such condition that almost any kind of a truck is not liable to get off the track. We sometimes have cases where wheels run without any flange a long distance, when it is discovered that they have broken a wheel sometimes. Now the question is,

which is the superior of these trucks? I think that we may safely assume, that an engine is guided safely just in proportion to the power that it takes to overcome the resistance that it is subjected to, and if a pair of wheels will wear out quicker under a mogul, then it follows that four wheels will guide that engine longer than two wheels, and liability to accident comes when they begin to approach a point where they are unsafe. Mr. Gibbs has touched the point exactly. We might say are sharp flanges unsafe, or rather is a sharp flange as safe as a full flange? We know that it is not, but just where the point of safety finishes is the question. We do not allow that to come. When the flange begins to get too sharp we take it out.

Now in regard to the link on the truck. I cannot for the life of me see, from a mechanical point of view or from a practical point of view, having run an engine for a good many years, why it is assumed that a vertical link has just the same vibration as an inclined link. I think there is no doubt at all but that the contrary is the fact. A vertical link is sensitive, and it swings and it keeps that nosing going all the time, when the inclined link prevents that.

MR. HICKEY—I would like to ask the committee a question in relation to weights on wheels. Three or four years ago this Association had the question up of the proper weights of driving-wheels, and what was the most economical weight as to the wear of tires. In question 7 here they ask: "What is the limit of weight, in your opinion, one driver should bear?" The general answer is 16,000 pounds for a rail under sixty pounds and 18,000 pounds for a rail above that weight. That is all right, so far as the rail is concerned. But what is the proper weight so far as the economical use of the tire is concerned? It was at the time I speak of, when that question was put, the Association felt as if a greater weight than 16,000 pounds per tire would not be good practice. I would like to know if that is the feeling existing at present.

MR. LEEDS—I hardly think that the committee ought to answer that question, for the reason that it has not been investigated, and it reduces itself right down to one man's opinion, so that the committee is simply one man. I do believe that 16,000 pounds is the full limit that ought to be put on the point of contact on a stone ballasted road. I think there is a great deal overlooked in the conditions. I have quite often watched the waves that run ahead of the wheel when the train is going pretty fast and I am sure that on a gravel ballasted road as against a stone ballast we get a greater point of contact. But when it comes to the weight on the drivers, it is a good deal as to where your joints are. If you are rolling along on one continuous rail, I do not think it disturbs the molecules of the metal to any great extent, but when you come to a pretty rough piece of track I think 16,000 pounds will give you blow enough under those conditions to do considerable injury to the tires. There is one thing that Mr. Barr brought up and elucidated pretty thoroughly that I was investigating at the same time, and I will say that he reversed

everything on it, and that was the point where the flat spot would come on the wheel on a sandy road. I was trying to work out the idea that it would come on a certain point where we get a thrust and slip on the wheel, and our practice and our experience all through the South would show that that was the fact. But in his diagrams he reverses the conditions entirely. I merely bring that up to say that with 16,000 pounds on a sandy road our tires will wear splendidly, with the exception of one spot that comes between the counter-balance and the crank pin, where they easily get a slap or a thrust of some kind that gives us a flat spot there every time. At the same time on these sandy roads we have got that large surface, that the rest of the tire wears very little, regardless of the fact that the rail is covered with sand nearly all the time.

MR. FORNEY—At the last annual Convention of this Association I had the pleasure, and I presume I may call it the honor, to propose a question as to the relative safety of pony and four-wheel trucks. I am very glad my question has borne fruit in this report and this discussion, and since coming here I have taken the opportunity to talk with a number of the members concerning this question, and I found one man who came out boldly with the statement that a pony truck is safer than a four-wheel truck, and that the burden of proof rests on the shoulders of those who advocate the four-wheel truck. When you come to look at it I think there is some reason for that opinion. If you could make an engine so that each axle would assume a radial position to the curve, and cone the wheels properly, that engine will roll around the curve as easily as on a straight track. Now as a matter of fact, with a pony truck, the axles assume a more nearly radial position to the curve than they do with a four-wheel truck, and for that reason it would seem as though the engine would be guided around the curve to better advantage with a pony truck than it would with an ordinary four-wheel truck.

Within a few months I was called upon by a railroad company to make a report with reference to the form of engine to be adopted for fast freight service, and the question turned upon that of either a mogul engine or a ten-wheeler, and I spent considerable time in hunting up the evidence with relation to the two, and was finally compelled to make a report and say that there seemed to be a prejudice in the minds of most master mechanics with reference to the pony truck, but that I could find no evidence to show that it was anything more than a prejudice, and I believe so to-day. I believe it is merely a prejudice, and that the pony truck, if properly constructed, would be as safe for running at high speed as the ordinary four-wheel truck.

Some years ago, when in England, in conversation with one of the locomotive superintendents there, he told me that they had introduced some four-wheel engines with the truck under the tank. When they were first introduced he had great difficulty in getting the men into running those engines with the truck ahead. They wanted to have the driving wheels in front, and felt more

secure then. The reason for that is that in England a very large number of engines are used in which the axles are all rigid, and they are accustomed to have the engine guide with the rigid axle. On the London, Brighton & Dover road they have engines with very large wheels, and the driving-wheels are run ahead, and they feel no danger in running engines of that kind. Latterly they have been building engines with substantially what is a pony truck. On the London & Northwestern road, I think nearly all their fast engines are run with a radial truck in front. With all the experience in England and the experience in this country in the use of mogul engines in all kinds of service, if there were any inherent defect in the pony truck, so far as keeping the engine on the track is concerned, it certainly would have been revealed in the discussions that have been held in this Association; and it therefore seems to me that it would be quite safe to conclude that the pony truck would be a safe instrumentality to use on fast express trains. (Applause.)

SECRETARY SINCLAIR—I agree, in a general way, with my friend Mr. Forney, that a mogul engine, when in good order, When the truck is in good order, is just as safe to run as an engine with a four-wheel truck. However, I thought that Mr. Gibbs struck a practical point that is very worthy of consideration. Those who have had charge of keeping eight-wheel engines or engines with a pony truck in running order, know that it is important to see that the front wheel flanges are not too sharp to be dangerous. In going around your engines you always keep your eye on the front wheels of the four-wheel trucks to see that they are all right, and you do the same with the pony truck. You find that the pony truck is much more liable to get out of order with its wheels than the four-wheel truck, and it seems to be a question merely of maintenance. The pony truck, properly constructed, that does not cut its flanges, is one that I have not yet run across. Perhaps they will be built yet, but I have never seen them. I know that the leading wheels used on the British roads were much given to the cutting of their flanges. It is a very easy matter to run large driving-wheels with little flange wear in front of locomotives on the London, Chatham & Dover, or on the London & Northwestern, with their straight lines. But if you get on to the Scotch lines, or some others, in Europe where the roads are curved, you see the same objection to large wheels in front that we find in this country, and in all kinds of wheels you meet with the trouble of cut flanges. To my mind the utility of a four-wheel and pony truck is merely a question of maintenance. You have got to keep your four-wheel truck safe and you have got to keep your two wheel truck safe. If either is in bad order it is not in a satisfactory condition to run, and no man with a proper sense of responsibility will run a truck when it is not in good order.

In regard to that question of the proper weight on driving-wheels, which was before this Association several years ago, it was considered that when more than 16,000 pounds was put on a wheel there was danger of rapid wear from abrasion, not from the sand or from any other exterior condition, but

merely the abrasion of the two surfaces; that the tire would wear rapidly, owing to excessive pressure between the surfaces. There is a rather interesting case to be found at present that throws light on this question. On the New York Central they are running a certain class of engines with about 20,000 pounds on a wheel, and they are getting about 25,000 miles between turnings for one-sixteenth inch wear. That would show that they have not reached the point even at that great weight where there was destructive wear from abrasion. My opinion, based on experience, is that the wear on the driving-wheel tires is much greater from slipping than it is from abrasion.

On motion of Mr. Swanston the discussion was closed.

THE PRESIDENT—The next subject, gentlemen, is the report of the Committee on Electrical Appliances for Railroad Use.

The Secretary read the following report:

ELECTRICITY IN RAILROAD SERVICE.

The committee to whom was referred the subject of Electrical Appliances for Railroad Use," after a full consideration of the subject, have been unable to formulate a report to be submitted at this meeting.

We find so few railroads have as yet adopted any of the methods for lighting, signaling, welding and kindred uses of electricity, or for utilizing it in connection with motive power, that no data of consequence and importance could be procured; we find that in the few attempts on some roads to utilize electricity for the purposes above mentioned, they are mainly of an experimental nature, and no satisfactory results have as yet been attained from which an intelligent and comprehensive report can be compiled.

We find that in addition to lighting and signaling that an attempt at traction increasing and braking is being made, but as yet the results would not warrant our embodying them in our report.

Your committee therefore suggest that this subject be made one for future consideration, and are of the opinion that in order to get reliable data and the true status of the subject, that a new committee should be appointed, consisting of members of our Association who are connected with the roads that

are now experimenting with or have already applied or used electricity for any of the purposes mentioned.

T. W. GENTRY,
G. B. HAZELHURST,
ALBERT GRIGGS,
JOHN ORTTON,

Committee.

DISCUSSION ON ELECTRICAL APPLIANCES.

On motion the report was accepted.

THE PRESIDENT—If there is no discussion on that subject I will announce the next subject.

SECRETARY SINCLAIR—I would like to hear from Mr. Gibbs on this subject. He is better posted on electrical matters connected with motive power than any other man in the Association, I believe, and if he considers it desirable to appoint a new committee at present, I think it should be done. If not, I think the committee should be dropped for a year, or until the subject develops.

MR. GIBBS—I see at present no direction where the committee could properly investigate the subject. Electricity has been applied in various ways to some slight extent, but it is of an experimental nature almost wholly, except possibly in the direction of car-lighting, where the consideration of advertising and attracting passenger patronage comes in, which could hardly be taken up here. I would therefore move that this subject be dropped from our consideration until further progress has been made in the direction to which the appliances are now being experimented with.

MR. BLACKWELL—Before that motion is put I would like to draw attention to the cranes that have been built for use in railroad shops during the last year, operated by electricity. Last week I had the pleasure of seeing, in the shops of the Baldwin Locomotive Works, in Philadelphia, some new cranes recently erected, operated by electricity, and I was very much pleased with them and their operation, having seen one in the erecting shop lifting one of the heaviest engines with a seventy-two inch shell, consolidation type, for the Northern Pacific road. The facility with which the crane handled the engine was so wonderful that I am sure every member would have enjoyed the sight. I think the matter of the application of electricity to cranes is of very great importance.

The motion to drop the subject was carried.

THE PRESIDENT—The next subject is that of Standards of the Association.

The Secretary read the following report:

STANDARDS OF THE ASSOCIATION.

The committee to whom was referred the subject of the Standards of the Association did not issue a circular, but have had some correspondence with each other and also with other members of the Association, and, as a result of these investigations, submit the following report:

The first important question that came up for our consideration was what class of subjects should be standardized by this Association, and here we found a wide difference of opinion, some having the opinion that such subjects as boiler construction, steam pressure, steam pipes, exhausts, wheel base, cylinders in relation to drivers, and, as expressed by one member, a thousand other matters, should be taken up by committees of the Association, with a view to making them standards. After carefully considering the subject, however, your committee have concluded that there are but few of these subjects that are not the matter of progress or evolution, and that the principle of the "survival of the fittest" will work out the standard when experience has developed and determined the best, and that only then should they be made standards of the Association.

The principal business of the members of this Association is connected with the construction, repairs, and operation of locomotives, and this work is confined to a system of roads operated by one company, or to a single independent road. The locomotives in their care not being interchangeable with other roads, and its operation and the care of it being confined to the road which owns it, we regard it as highly important that each road should adopt standards of locomotive construction best adapted to the service required and the geographical position in which they are located, but we do not regard it as essential that the standards of all roads should be the same.

Your committee are in accord with the views expressed in the annual address of the president of this Association at the meeting in 1888 at Alexandria Bay, and believe that the object of this Asso-

ciation is educational; that through its committees on different subjects the results of the differences in practice of the members should be presented, with a recommendation of the best, but not adopted as a standard until all are agreed that no further improvement can be made, as the adoption of imperfect standards by this Association would have the tendency to prevent the investigations which it is our object to encourage.

This view of what the Standards of the Association should be suggests that for the present they be confined to such subjects as are indicated by the following standards already adopted:

United States Screw-threads, Micrometer Gauge for Sheet Metal, Limit Gauges for Bar Iron, and Gauges for Driving-wheel Centres and Tire. These standards, and others of a like nature which may be added, are important in our dealings with manufacturers, and the general adoption of these will be in the interests of economy, and your committee would recommend that they be maintained and re-affirmed as Standards of this Association. But the axles for light and heavy tenders and the tests and specifications for cast-iron wheels should not be standard, but should have the indorsement and recommendation of the Association, to be adopted by the members as they may see it to the interests of the road they serve. Of the Journal Bearing, Journal box and Pedestal, these standards were adopted by a joint committee appointed by the Master Car Builders and this Association, and your committee are of the opinion that it was proper to approve the recommendation of that committee, but that it should not be regarded as a Standard of this Association. The only other standard which has been adopted by this Association is that of making six miles per hour the standard mileage for engines in switching service. The committee think this is the general practice, and should have the recommendation of the Association, but it is not of sufficient importance to be placed on the list of standards.

WILLIAM SWANSTON,
C. H. CORY,
J. S. McCRUM,
WILLIAM GARSTANG,
THOMAS SHAW,
Committee.

DISCUSSION ON THE STANDARDS OF THE ASSOCIATION.

A motion to receive the report was carried.

MR. LAUDER—I would like to say a word, without taking up too much time, about one of the standards of the Association, and that is the standard size for driving wheel centers. That was rather a pet of mine that I had something to do with getting established, and of course I feel a personal interest in having it properly carried out. I have reason to believe that many of the roads that are ostensibly using this standard are making their own gauges. Now that practice, while it may save them the buying of a set of Pratt & Whitney's gauges as recommended and arranged for by the committee —while it may save them a few dollars, in a few years, if it is continued, that standard will be of no earthly account to the manufacturers or to ourselves, because no two men can measure four feet or five feet or six feet alike even with the United States standard measuring scale. Temperature has something to do with it, the different methods of manipulation of the scale have something to do with it. I doubt whether any man in this room can take a two-foot steel scale and measure six or seven feet and get anywhere near alike twice. Now in order to make that particular standard, which is of vast importance to the safe running of an engine—in order to make that standard reliable and what it should be and what it was intended to be, no man should make his own gauges. I am not here to advocate any work for Pratt & Whitney, because I am very certain that every set of gauges they make they lose money on. Those gauges are made and warranted to be within $\frac{1}{10000}$ of an inch at a temperature of 62°. Nobody else in this country can work down anywhere near as fine as that, and perhaps the gauges do not need to be as fine as that, but they want to be absolutely alike. Then every tire manufacturer, when he gets an order for tires bored, they are bored, and we know they are bored to the standard gauge. When the wheels are turned in the shops of a company, they are turned to the gauge and we know then that shrinkage is absolutely right. Now I believe that ninety-nine per cent. of the steel tires that have been broken since steel tires came into use, have been broken because of the persons who have applied them to the wheels. Now we lay this to the tire maker, which is wrong. We take the chances of producing disaster on the road by such practice. I know of one locomotive builder to-day who never has got a set of those gauges. If he ever built any engines for me he would buy a set, or he wouldn't sell the engines. I am informed that all the tire makers have them and I believe that nearly all the locomotive builders have them, and certainly the members of this association, at least, should see to it that they have a set of gauges. I would say for myself that I have a set of those gauges for every shop on our road. The whole set costs in the box complete $125—less I think than they can be made for.

THE PRESIDENT—I would say that I think some action should be taken on

this report in the way of adopting the recommendations made by the committee. A motion to that effect would be entertained.

MR. SWANSTON—The intention of the report is to reduce the standards of the Association to just what the report calls for. Those that are not recommended will not after this (that is if you adopt the report) be considered standards of the Association. They will still be just like anything else that we have passed on—recommendations of the Association and not standards of the Association. I think it would be important to take that action.

THE PRESIDENT—The adoption of the report of the Committee?

MR. SWANSTON—Yes, sir. I do not want to make that motion, as I wrote the report.

MR. SETCHEL—I move that the recommendation of the committee be adopted.

The motion was carried.

THE PRESIDENT—The next report is on Air Brake Standards and Inspection and Repair of Air Brakes. I would say, gentlemen, that this report is the report of a joint committee of the Master Car Builders and the Master Mechanics and that the subject has been continued in the Master Car Builders Association, owing to some technical differences existing in the report. It seems to me that we ought to take the same action—continue the committee.

The Secretary read the following report:

AIR BRAKE STANDARDS AND INSPECTION AND CARE OF THE AIR BRAKE.

Your committee, which was appointed to confer with and act jointly with the committee appointed by the Master Car Builders' Association upon the Air Brake Standards and Inspection and Care of Air Brakes Upon Freight Cars, would report to you as follows:

The matter of applying brake gear of suitable construction and proper proportions to air brake freight cars, became of such importance in the securing of an efficient and uniform operation of the air brake in freight trains, that the Master Car Builders' Association, some time since, adopted a standard system of brake gear for all freight cars equipped with the air brake.

One of the questions before the committee of that Association this year was whether it is desirable to make any alterations in the existing standards. The committee sent out a circular letter for information upon this subject, and from the statistics

compiled from the replies to these letters, and from such investigation as the committee could make, they decided unanimously to recommend the use of an iron brake beam wherever the air brake is applied to cars.

It further appeared, from the statistics above mentioned, that a very large proportion of all the freight cars which have been equipped with the air brake within the last two years have also been supplied with a mètallic brake beam.

Your committee feels the importance of the use of a thoroughly efficient system of brake gear in connection with the use of the air brake, and the same reasons which make it desirable upon cars, also make it equally important that such a brake beam should be used wherever the air brake is applied.

We therefore recommend and urge the application of an iron brake beam to tender trucks, and that the same be made a standard in all cases where the air brake is applied.

In the joint deliberations of these committees it also appeared absolutely essential to the securing of uniform and good results from the operation of the air brake, that uniform methods of careful inspection and test of the air brake apparatus, both upon locomotives and upon cars, should be instituted and maintained upon all railroads using the same.

There is no doubt in the minds of your committee that the results obtained in the use of the air brake have fallen very far short of the best which it is possible to obtain. The railroad companies, having expended a large amount of capital in the equipment of their rolling stock with the air brake, should reasonably expect to obtain all the advantages which may be derived from its use.

To secure this efficiency, therefore, and to obtain a uniform service of the best nature from the air brake, the joint committee has carefully considered and prepared a system of rules, directed to each class of employés, which is engaged either in the operation or maintenance of the air brake apparatus. To further insure the possession, by each such employé, of such information and instruction as will enable him to intelligently perform his duties, the committee has recommended a

personal examination of each such employé, by some suitably appointed person, and has also prepared a system of questions and answers as a guide for such examination, and which will insure the very desirable result of the instruction of all employés upon all roads alike.

It is proposed that the rule governing employés, concerning the air brake, and the system of questions and answers for examination, be printed and bound together, in pamphlet form of a suitable size, so that each employé may be provided with a copy, conveniently arranged to be carried in the pocket. Accompanying this report and forming part of the same, will be found, printed in such a form as the committee recommends, this system of rules and instructions, and your committee earnestly recommends that the same be adopted by this Association, in so far as it applies to employés coming under the direction of its members.

To further secure absolute uniformity in the printing of the same, it is recommended that this pamphlet be printed and sold to the railroads by the Master Car Builders' Association, in the same manner in which the Code of Rules of Interchange is now prepared.

R. C. BLACKALL,
G. W. STEVENS,
D. CLARK,
Committee.

GENERAL INSTRUCTIONS.

The following rules and instructions are issued for the government of all employees of this railroad whose duties bring them in contact with the maintenance or operation of the Westinghouse air brake and train air signal. They must be obeyed in all respects, as employees will be held responsible for the observance of the same, as strictly as for the performance of any other duty.

Every employee, whose duties are connected in any way with the operation of the air brake, will be examined as to his qualification for such duties by the Inspector of Air Brakes or other person appointed by the proper authority. Every such employee will be required to have in his possession a

certificate of competency to perform those duties, which will be given him only after having passed a satisfactory examination.

The Westinghouse Air Brake Company has issued, in convenient form, a complete explanation of all parts of the air brake and train air signal equipment, with directions for the care and operation of the same. Any employee of this railroad will be furnished with a copy of the same, upon application at place designated by special notice, and every employee will be held responsible for a full knowledge of his duties in the operation or maintenance of the air brake or signal equipment. If the directions contained in that book are observed and the rules and instructions herewith are obeyed, no failure of the air brake, at the time when it is needed, should occur. If such a failure does occur, it will be assumed that some employee has neglected his duty, and an investigation will be made to ascertain who is responsible for such failure.

Signed..............................

INSTRUCTIONS TO ENGINEMEN.

GENERAL.—Engineers, when taking their locomotives, must see that the air brake apparatus, on locomotive and tender, is in good working order; that the air pump and lubricator work properly; that the pump regulator stops the pump when the maximum train pipe pressure of seventy (70) pounds is obtained; that an excess pressure of not less than twenty pounds is maintained in the main reservoir when the handle of the engineer's brake valve is placed in position 2 (Running Position); that the engineer's brake valve works properly in all different positions of the handle; and that, when the brakes are fully applied, the driver brake pistons do not travel less than one-third nor more than two-thirds of their stroke, and the tender brake piston does not travel less than four nor more than eight inches.

Engineers must report to roundhouse foreman, at the end of the run, any defect in the air brake or signal apparatus discovered on the road.

MAKING UP TRAINS AND TESTING BRAKES.—Be sure to have seventy pounds train pipe pressure on the engine, with the handle of the engineer's valve standing in position 2, before connecting to the train.

When coupled to the train and the black pointer of the air gauge has become stationary or begun to rise a little, place the handle in position 3 and note whether the black pointer remains stationary or falls back. If the pointer falls back, it indicates a leak in the train apparatus, and the rapidity with which the pressure falls indicates the extent of the leak. No train must be started out with a serious leak in the pipe or apparatus.

After the engineer is satisfied that there are no serious leaks in the train, he will, at a signal from the inspector or trainmen, apply the brakes and leave them so applied until the brakes on the entire train have been inspected.

THE ENGINEER'S BRAKE AND EQUALIZING DISCHARGE VALVE AND DUPLEX AIR GAUGE.

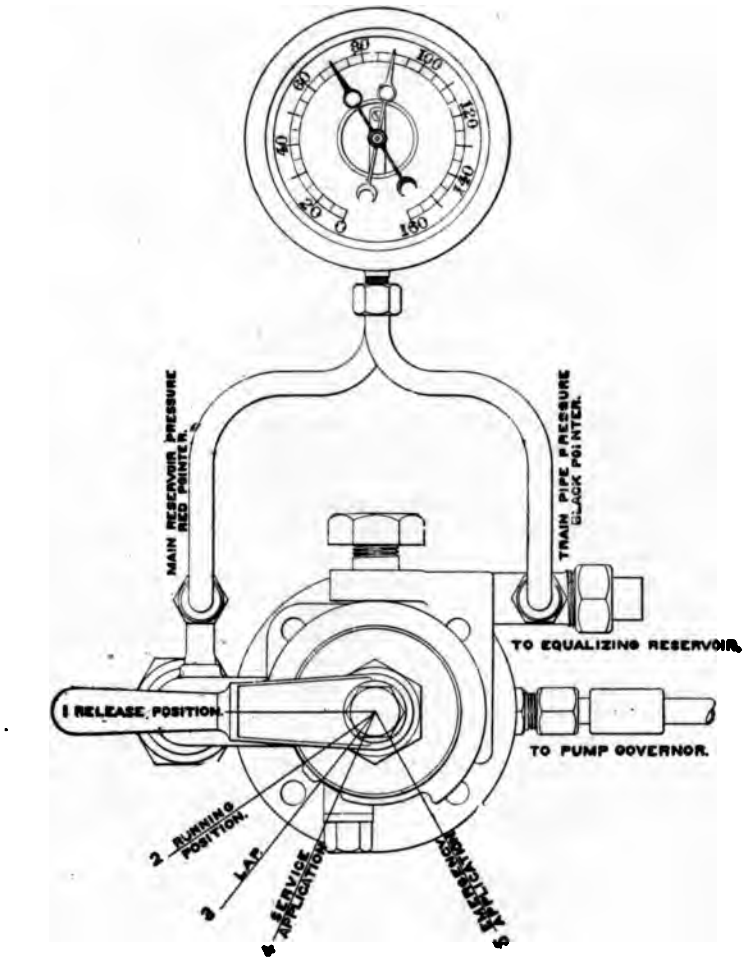


FIG. 1.

and the signal is given to release. He shall then release the brakes, and shall not leave the station until it has been ascertained that all brakes are released and he has been informed by the inspector or conductor that the brakes operate all right. Where the train air signal is used, the signal to release the brakes, in testing, will be given from the rear car of the train, to show that the signal connections have been properly made.

SERVICE APPLICATION.—In applying the brakes to steady the train upon descending grades, or for reducing the speed for any purpose, be very careful not to make too great a reduction of pressure in the outset, as the speed of the train will be too quickly or too much checked, and it will be necessary to release the brakes and apply them again later, perhaps repeating the operation. *Apply the brakes lightly at a sufficient distance from the stopping point, and increase the braking force gradually, as is found necessary, so as to make the stop with one application, or at most two applications of the brakes.*

With freight trains which are only partially equipped with the air brake, great care must be used to apply the brakes with only from six to eight pounds reduction, and to allow the slack of the train to be taken up before further application is made, in order to prevent shocks, which otherwise may be serious.

In making a service stop, *always release the brakes a short distance before coming to a dead stop,* except on heavy grades, to prevent shocks at the instant of stopping. Even on moderate grades, it is best to do this, and then, after release, to apply the brakes lightly to prevent the train starting, so that when ready to start the release will take place quickly.

EMERGENCY APPLICATIONS.—The emergency application of the brakes must not be used, except in actual emergencies.

BRAKES APPLIED FROM AN UNKNOWN CAUSE.—If it is found that the train is dragging at any time without a rapid fall of the black pointer, move the handle of the engineer's valve into the full release position for a few seconds, and then return it to the running position.

If, however, the brakes go on suddenly, with a fall of the black pointer, it is evidence that (*a*) a conductor's valve has been opened, (*b*) a hose has burst or other serious leak has occurred, or (*c*) the train has parted.

In such an event, place the handle immediately in position 3, to prevent the escape of air from the main reservoir, and leave it there until the train has stopped, the brake apparatus has been examined and a signal to release is given.

BRAKING BY HAND.—*Never use the air brake* when it is known that the trainmen are operating the brakes of the air brake cars by hand, as there is danger of injury to the trainmen by so doing.

CUTTING OUT BRAKES.—*The driver and tender brakes must always be used automatically at every application of the train brakes,* unless defective—except upon such grades as shall be designated by special instructions; in which

cases, the driver brake shall be cut out and used separately, as a straight air brake.

When necessary to cut out either driver or tender brake, on account of defects, it shall be done by turning the handle of the four-way cock in the triple valve down, to a position midway between a horizontal and a vertical position.

DOUBLE HEADERS.—When two or more engines are coupled in the same train, the brakes must be connected through to, and operated from the head engine. For this purpose, a cock is placed in the train pipe, just below the engineer's valve. The engineer of each engine, except the head one, must close this cock and place the handle of the engineer's valve in position 2. He will start his air pump and let it run, as though he were going to use the brake, for the purpose of maintaining air pressure on his engine and enabling him to assume charge of the train brakes should occasion require it.

AN EXTRA AIR BRAKE HOSE AND COUPLING must always be carried on the engine for repairs, in case of a burst hose. Upon engines having the air signal, a signal hose and coupling must also be carried for the same purpose.

INSTRUCTIONS TO TRAINMEN.

MAKING UP TRAINS AND TESTING BRAKES.—When the engine has been coupled to the train, or when two sections have been coupled together, the brake and signal couplings must be united, the cocks in the train pipes—both

THE ANGLE COCK.

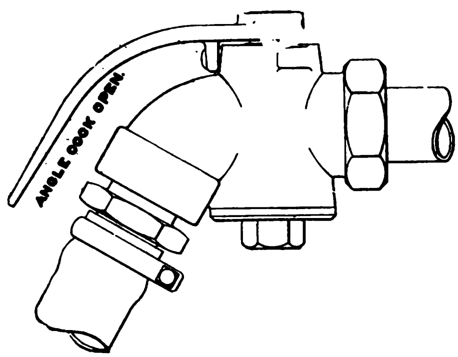


Fig. 2.—Angle Cock open.

brake and signal—must all be open except those at the rear end of the last car, which must be closed, and the hose hung up properly in the dummy coupling.

After the engineer has charged the train with air, he must then be signaled to apply the brakes. When he has done so the brakes of each car must be examined, to see if they are properly applied. When it is ascer-

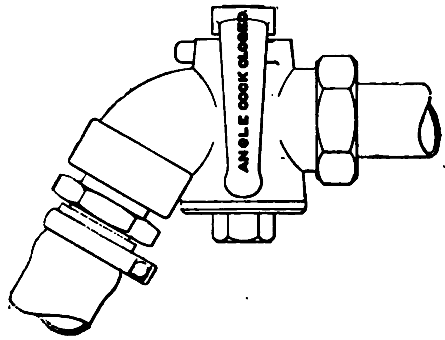


Fig. 3.—Angle Cock closed.

tained that each brake is applied, the engineer must be signaled to release the brakes. When the train air signal is to be used, the signal to the engineer to release the brakes must be given by means of the air signal from the rear

THE PLAIN STRAIGHT-WAY COCK.

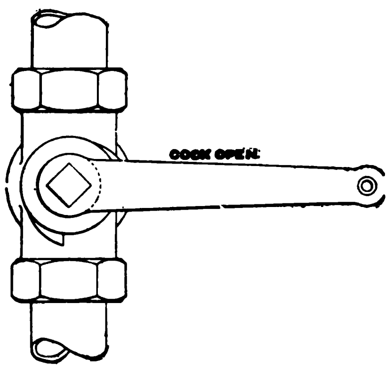


Fig. 4.—Cock closed.

car of the train. The brakes of each car must then be examined to see that each is released.

If any defect is discovered, it must be remedied and the brakes tested

again—the operation being repeated until it is ascertained that everything is right. The conductor and engineer must then be notified that the brakes are all right. No passenger train must be started out with the brakes upon any car cut out, or in a defective condition, without special orders from the proper officers. At points where there are no inspectors, trainmen must carry out these instructions. The air brakes must not be alone relied upon to control any freight train with a smaller proportion of cars with the air brake in service, than the division time-card specifies.

DETACHING ENGINE OR CARS.—First close the cocks in the train pipes at the point of separation, and then part the couplings, invariably by hand. If

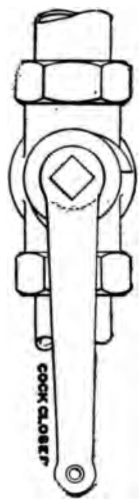


Fig. 5.—Cock open.

the brakes have been applied, do not close the cocks until the engineer has released the brakes upon the whole train.

COUPLINGS FROZEN.—If the couplings are found to be frozen together or covered with an accumulation of ice, the ice must first be removed and then the couplings thawed out by a torch, to prevent injury to the gaskets.

BRAKES STICKING.—If brakes are found sticking, the engineer must be signaled to release them. If he cannot do so and calls for release, or if brakes are applied to detached cars, the release may be effected by opening the small cock in the auxiliary reservoir, until the air begins to release through the triple valve, when the reservoir cock must immediately be closed.

TRAIN BREAKING INTO TWO OR MORE PARTS.—First close the cock in the train pipe at the rear of the first section, and signal the engineer to release the brakes. Having coupled to the second section, observe the rule for making up trains—first being sure that the cock in the train pipe, at the rear of the second section, has been closed, if the train has been broken into more than two sections. When the engineer has released the brakes on the second section, the same method must be employed with reference to the third section, and so on. When the train has been once more entirely united, the brakes must be tested, as in making up a train.

THE PLAIN AUTOMATIC TRIPLE VALVE.

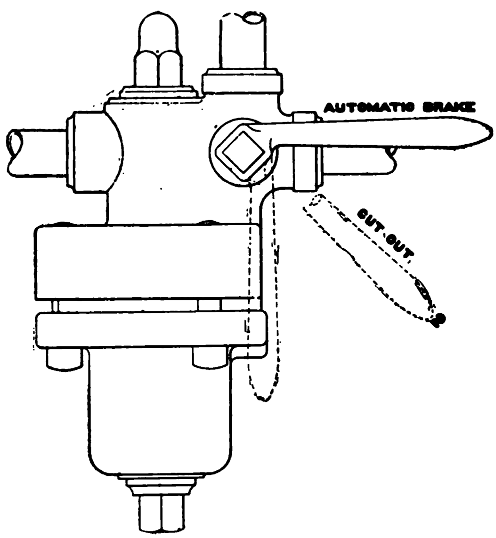


Fig. 6.

CUTTING OUT THE BRAKE ON A CAR.—If, through any defect of the brake apparatus, while on the road, it becomes necessary to cut out the brake upon any car, it may be done by closing the cock in the cross over pipe, near the centre of the car, where the quick acting brake is used, or by turning the handle of the cock in the triple valve to a position midway between a horizontal and vertical, where the plain automatic brake is used. When the brake has been thus cut out, the cock in the auxiliary reservoir must be opened and left open until all the air has escaped from the reservoir. *The brake must never be cut out upon any car unless the apparatus is defective*, and when it is

necessary to cut out a brake the conductor must notify the engineer and also send in a report stating the reasons for so doing.

CONDUCTOR'S VALVE.—Should it become necessary to apply the brakes from the train, it may be done by opening the conductor's valve, placed in each passenger equipment car. *The valve must be held open until the train comes to a full stop, and then must be closed again.*

This method of stopping the train must not be used except in case of emergency.

BURST HOSE.—In the event of the bursting of a brake hose, it must be replaced and the brakes tested before proceeding.

BRAKES NOT IN USE.—When the air brakes are not in use, either upon the road or in switching, the hose must be kept coupled between the cars or hung up properly to the dummy couplings.

THE PRESSURE RETAINING VALVE.

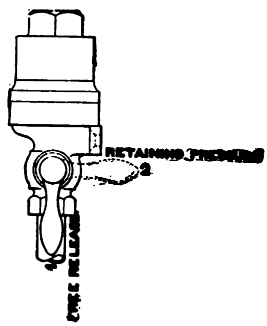


Fig. 7.

PRESSURE RETAINING VALVE.—When this valve is to be used, the trainmen must, at the top of the grade, test the brakes upon the whole train, and must then pass over the train and turn the handles of the pressure retaining valves horizontally (Position 2) upon all or a part of the cars, as may be directed. At the foot of the grade, the handles must all be turned downward again (Position 1). Special instructions will be issued as to the grades upon which these valves are to be used.

TRAIN AIR SIGNAL.—In making up trains, all couplings and car discharge valves on the cars must be examined to see if they are tight. Should the car discharge valve upon any car be found to be defective while on the road, it may be cut out of use upon that car by closing the cock in the branch pipe leading to the valve. The conductor must always be immediately notified

when the signal has been cut upon any car, and he must report the same for repairs.

In using the signal, pull directly down upon the cord during one full second, for each intended blast of the signal whistle, and allow two seconds to elapse between the pulls.

REPORTING DEFECTS TO INSPECTORS.—Any defect in either the air brake or air signal apparatus discovered upon the road must be reported to the inspector at the end of the run ; or, if the defect be a serious one in passenger service, it must be reported to the nearest inspector, and it must be remedied before the car is again placed in service.

INSTRUCTIONS TO ENGINE-HOUSE FOREMAN.

GENERAL.—It is the duty of engine-house foremen to see that the air brake and signal equipment, is properly inspected upon each engine after each run. It must be ascertained that all pipe joints, connections and all other parts of the apparatus are air tight, and that the apparatus is in good working order.

AIR PUMP.—The air pump must be tested under pressure, and if found to be working imperfectly in any respect, it must be put into thoroughly serviceable condition.

PUMP GOVERNOR.—The pump governor should cut off the steam supply to the pump, when the train pipe pressure has reached seventy (70) pounds. If it does not, it must be regulated to do so.

ENGINEER'S BRAKE VALVE.—This valve must be kept clean and in perfect order. With the handle in position 2, the main reservoir pressure must not be less than 20 pounds greater than train pipe pressure. The valve must be tested with the handle in positions 4 and 3, to note that the equalizing piston responds promptly and that there are no leaks from port to port under the rotary disc valve.

ADJUSTMENT OF BRAKES.—The driver brakes must be so adjusted that the pistons travel not less than one-third nor more than two-thirds of their stroke. When the cam brake is used, care must be taken to adjust both cams alike, so that the point of contact of the cams shall be in line with the piston rod. The tender brake must be adjusted by means of the dead truck levers, so that the piston travels not less than 4 nor more than 8 inches when the air brake is applied and the hand brake is released.

BRAKE CYLINDERS AND TRIPLE VALVES.—These must be examined and cleaned once every six months, and the cylinders oiled once in three months. If the driver brake cylinders are in a position to be affected by the heat of the boiler, they must be oiled more frequently. A record must be kept of the dates of last cleaning and oiling for each engine.

DRAINING.—The main reservoir must be drained of any accumulated

water after each trip, and the drain cup in train pipe under the tender frequently. The auxiliary reservoirs and triple valves must also be frequently drained, especially in cold weather.

Air Signal.—The train air signal apparatus must be examined and tested by opening and closing the cock in the signal pipe, at the rear of the tender, to see that the whistle responds properly. A pressure gauge must be applied to the air signal pipe, once each month, to ascertain that the reducing valve maintains the proper pressure of 25 pounds per square inch in the train signal pipe.

INSTRUCTIONS TO INSPECTORS.

General.—It is the duty of all inspectors to see that the couplings, the pipe joints, the conductor's valves, the air signal valves, and all other parts of the brake and signal apparatus are in good order and free from leaks. For this purpose they must be tested under a full air pressure of 70 pounds, and any defects found must be remedied. No passenger train must be allowed to leave a terminal station with the brake upon any car cut out, or in a defective condition, without special orders from the proper officer.

If a defect is discovered in the brake apparatus of a freight car, which cannot be held long enough to give time to correct such defect, the brake must be cut out and the car properly carded, to call the attention of the next inspector to the repairs required.

The division time card rules specify the smallest proportion of freight cars with the air brakes in good condition which may be used in operating the train as an air brake train.

Making Up Trains and Testing Brakes.—In making up trains, the couplings must be united and the cocks at the ends of the cars all opened, except at the rear end of the last car, where the cocks must be closed and the couplings properly hung up to the dummy couplings. After the train is charged, the engineer must be signaled to apply the brakes. When the brakes have been applied, they must be examined upon each car to see that they are properly applied. This having been ascertained, the inspector must signal the engineer to release the brakes, using the train air signal from the rear car. He must then again examine the brakes upon each car to note that each is released. If any defect is discovered it must be corrected and the testing of the brakes repeated, until they are found to work properly upon each car. The inspector must then inform both the engineer and conductor that the brakes are all right.

Cleaning Cylinders and Triple Valves.—The brake cylinders and triple valves must be kept clean and free from gum. They must be examined for this purpose once in six months. The cylinders must be oiled once every three months, and the dates of last cleaning and oiling marked with chalk

upon the cylinder in the places left for such dates opposite the words, which will be stenciled with white paint, in one-inch letters, upon the cylinder, as follows:

CYL. OILED ....

CYL. } CLEANED ....
TRIPLE }

The triple valves and auxiliary reservoirs must be frequently drained, especially in cold weather, by removing the plug in the bottom of the triple valve and opening the small cock in the reservoir.

ADJUSTMENT OF BRAKES.—The slack of the brake shoes must be taken up by means of the dead truck-levers.

In taking up such slack, it must be first ascertained that the hand brakes are off, and the slack is all taken out of the upper connections, so that the live truck-levers do not go back within 1½ inches of the truck timber or other stop, when the piston of the brake cylinder is fully back at the release position. The adjustment must be such that the pistons shall move not less than four nor more than eight inches, when the brakes are fully applied.

BRAKING POWER.—Where the cylinder lever has more than one hole at the outer end the different holes are for use upon cars of different weights.

It must be carefully ascertained that the rods are connected to the proper holes, so that the correct braking power shall be exerted upon each car.

REPAIR PARTS.—Inspectors must keep constantly on hand for repairs a supply of all parts of the brake and signal equipment that are liable to get out of order.

HANGING UP HOSE.—Inspectors must see that, when cars are being switched or standing in the yard, the hose is coupled between the cars or properly secured in the dummy coupling.

RESPONSIBILITY OF INSPECTORS.—Inspectors will be held strictly responsible for the good condition of all the brake and signal apparatus upon cars placed in trains at their stations; they will also make any examination of brake apparatus or repairs to the same, which they may be called upon to do by trainmen.

GENERAL QUESTIONS

REGARDING THE USE OF THE

WESTINGHOUSE AIR BRAKE AND TRAIN SIGNAL

GENERAL QUESTIONS.

(All parties who have to do with the use, adjustment, care or repairs of air brakes should be thoroughly examined on these questions, in addition to the special questions for each class of men following them.)

1. Question. What is an air brake?

Answer. It is a brake applied by compressed air.

2. Q. How is the air compressed?

A. By an air pump on the locomotive.

3. Q. How does the compressed air apply the brakes?

A. It is admitted into a brake cylinder on each car, and it pushes out a piston in that cylinder which pulls the brake on.

4. Q. How does the piston rod get back when the brakes are released?

A. There is a spring around the piston rod which is compressed when the brakes are applied, and when the air is allowed to escape to release the brakes, this spring reacts and pushes the piston in again.

5. Q. What was the first and simplest form of air brake?

A. The straight air brake.

6. Q. How was the straight air brake applied and released?

A. The engineer applied the brake by admitting air from the reservoir on the locomotive through a train pipe to all the brake cylinders, and he released the brakes by first shutting off the reservoir from the train pipe, and then opening the train pipe and all the brake cylinders to the atmosphere, so that the compressed air could escape again.

7. Q. Is the use of the straight air brake now allowable?

A. No.

8. Q. Why not?

A. Because it has been replaced by an improved form of brake, called the automatic brake.

9. Q. Why is it called an automatic brake?

A. Because it is applied automatically by any derangement which reduces

the air pressure in the train pipe, such as by the bursting of a hose or the parting of a train.

10. Q. What necessary parts has the automatic brake on a car which the straight air brake had not?

A. One auxiliary reservoir and one triple valve.

11. Q. Where is the compressed air kept ready for use in the automatic air brake?

A. In the main reservoir on the locomotive, in the smaller or auxiliary reservoir on each car and in the train pipe.

12. Q. Where does the compressed air come from directly, that enters the brake cylinder when the automatic brake is applied?

A. It comes from the auxiliary reservoir on each car.

13. Q. How does it get into the auxiliary reservoir?

A. It is furnished from the main reservoir on the locomotive through the train pipe when the brakes are released.

14. How is the automatic brake applied and released?

A. The automatic brake is applied by reducing the air pressure in the train pipe at the locomotive or at any other point, and is released by restoring the pressure on the train pipe from the main reservoir on the locomotive.

15. Q. Why does the compressed air not enter directly into the brake cylinder from the train pipe, as in the straight air brake?

A. Because the triple valve used with the automatic brake prevents the air from entering directly from the train pipe to the brake cylinder when the pressure in the train pipe is maintained or increased.

16. Q. What other uses has the triple valve?

A. It causes the brake cylinder to be opened to the atmosphere under each car, and releases the brakes when the pressure in the train pipe is restored from the locomotive, and it opens communication from the train pipe to the auxiliary reservoir by the same movement; when the pressure in the train pipe is reduced, it closes the openings from the train pipe to the auxiliary reservoir and from the brake cylinder to the atmosphere, and then opens the passage between the auxiliary reservoir and the brake cylinder by the same movement, so as to admit the air and apply the brakes.

17. Q. How many forms of triple valves are there in use, and what are they called?

A. Two; the plain triple and the quick-acting triple.

18. Q. How can you tell the plain triple from the quick-acting triple?

A. The plain triple has a 4-way cock in it with a handle for operating the cock; the quick-acting triple has no such cock in it, but there is a plug cock in the cross-over pipe leading from the train pipe to the triple when the quick-acting triple is used.

19. Q. What are these cocks for, in both cases?

A. They are to be used to cut out brakes on one car, without interfering with other brakes on the train, if the brake on that car has become disabled.

20. Q. How does the cock handle stand in the plain triple valve when pipe is open for automatic action?

A. It stands in a horizontal position.

21. Q. In what position does the same handle stand when the brakes are cut out by closing the cock?

A. It stands at an inclined position, midway between horizontal and vertical.

22. Q. Can this cock handle be placed in any other position, and what?

A. In the older form of plain triple valve it can be moved to a vertical position.

23. Q. What was this position for, and is it still used?

A. This was to convert the automatic brake into a straight air brake, and it was needed when some cars were equipped with straight air brake and some with automatic brake, but it is not now used.

24. Q. How does the handle of the plug in cross-over pipe, used with the quick-acting triple, stand for automatic action?

A. It stands with the handle crosswise with the pipe, and the cock is then open.

25. Q. How does it stand when the cock is closed and the brake cut out of action?

A. It stands with handle lengthwise of cross-over pipe.

26. Q. How is the train pipe coupled up between the cars?

A. By means of a rubber hose on each end of the train pipe, fitted with a coupling at the loose end.

27. Q. How is the train pipe closed at the rear end of the train?

A. By closing the cock in the train pipe at the rear end of the last car.

28. Q. How many such train pipe cocks are there to a car, on the air brake train pipe and on the air-signal train pipe, and why?

A. Two for each pipe on each car, because either end of any car may sometimes be at the rear end of the train.

29. Q. How many kinds of train pipe cocks are there in use at the ends of the cars?

A. Two.

30. Q. Describe each, and give the position of the handles for open and closed in each case?

A. The older form of train pipe cock is a straight plug cock in the train pipe not far from the hose connection; the handle stands crosswise with the pipe when it is open, and lengthwise with the pipe when closed; it is now found principally on the air-signal pipe. The other form of train pipe cock, now used on the air-brake pipe, is an angle cock placed at the end of the train pipe and close to the hose. The handle of the angle cock stands lengthwise with the pipe when open, and crosswise with the pipe when closed.

31. Q. What uses have these train pipe cocks besides to close the pipe at the rear end of the train?

A. They are to be used to close the train pipe at both sides of any hose coupling which is to be parted, as when the train is cut in two.

32. Q. Why is it necessary to close the train pipe on both sides of the hose coupling before it is parted?

A. To prevent the escape of air from the train pipe which would apply the brakes.

33. Q. How must the hose coupling be parted when it is necessary to do so, and why?

A. The air brake must first be released on the train, then the adjacent train pipe cocks must both be closed and the coupling must be parted by hand, to prevent the possibility of injury to the rubber gasket in the coupling.

34. Q. Why must the brakes be fully released before uncoupling the hose between the cars?

A. Because if the brakes are applied upon a detached car, they cannot be released without bleeding the auxiliary reservoir, and thus wasting air.

35. Q. In coupling or uncoupling the hose between the cars, what must be done if there is ice upon the couplings?

A. The ice must first be removed and the couplings thawed out, so as to prevent injury to the rubber gaskets in uncoupling, and to insure tight joints in uncoupling the hose.

36. Q. What must be done with a hose coupling which is not coupled up, such as the rear hose of a train, or any hose on a car which is standing or running, but not in use?

A. It must be placed in the dummy coupling provided for it on each end of each car, in such manner that the flat pad on the dummy will close the opening in the coupling.

37. Q. Why is this important?

A. Because if it is not done properly, dust and dirt will enter the hose, and, when it is again coupled up in service, this dirt will be blown into the triple valve and interfere with its proper working, and will cause it to wear out more rapidly.

38. Q. What pressure should be carried in the train-pipe and auxiliary reservoir?

A. Seventy pounds pressure to the square inch.

39. Q. Why should this pressure be 70 pounds?

A. Because this pressure is necessary, to get the full braking force which each car is capable of using, and, if it be exceeded, there will be danger of sliding the wheels.

40. Q. How much pressure can be obtained in the brake cylinder by the ordinary application of the brakes with 70 lbs. in the auxiliary reservoir?

A. About 50 lbs. pressure to the square inch.

41. Q. Why can only 50 lbs. pressure be obtained under these circumstances?

A. Because the air, at 70 lbs. pressure in the auxiliary reservoir expands

into a larger space when the auxiliary reservoir is opened to the brake cylinder, and. when the pressure has become equalized it is thus reduced to 50 lbs.

42. Q. How much must the train-pipe pressure be reduced, in order to get 50 pounds pressure in the brake cylinder, in ordinary service?

A. Twenty pounds; or from 70 pounds down to 50 pounds in the train-pipe also.

43. Q. Can the brakes be applied so as to get only a portion of this 50 pounds pressure in the brake cylinder, and how?

A. They can be so applied by reducing the train-pipe pressure less than 20 pounds.

44. Q. If the train-pipe pressure be reduced 10 pounds what will the pressure be in the brake cylinder?

A. About 25 pounds.

45. Q. How is this graduated action obtained?

A. By means of the graduating valve in the triple valve.

46. Q. Is it important to keep all the air-brake apparatus tight and free from leaks?

A. Yes.

47. Q. Why is this important?

A. In order to get full service from the air brakes, and to prevent the waste of air, and also to prevent the brakes applying automatically by reason of leak in the train-pipe.

48. Q. Is it important to know that the train-pipe is open throughout the train and closed at the rear end before starting out?

A. Yes, this is very important.

49. Q. Why is this very important?

A. Because if any cocks in the train-pipe were closed, all the brakes back of the cock which is closed would be prevented from working.

50. Q. How can you know that the train-pipe cocks are all open when the train is made up?

A. By testing the brakes; that is, by applying and releasing them, and observing whether they all operate.

51. Q. Do you understand that no excuse will be acceptable for starting out the train without first testing the air brakes?

A. Yes.

52. Q. Why is this rule absolute?

A. Because the safety of passengers and of property depends upon the brakes being properly coupled up and in an operating condition before the train is started.

53. Q. At what other times should the brakes be tested, and how?

A. Before starting the train down a heavy grade, and the test should be made with a full application of the brakes.

54. Q. How much air pressure should be carried in the air-signal train pipe?

A. Twenty-five pounds pressure.

55. Q. Is it important that this train-pipe and its connections be also kept tight?

A. Yes.

56. Q. How far should the brake piston travel in the cylinders on cars and tenders with a full application of the brake?

A. Not less than four inches nor more than eight inches.

57. Why should they travel not less than four inches?

A. Because it is necessary to have them travel four inches in order to fully close the leakage groove provided in the brake cylinder for the escape of small amounts of air which may leak through the triple valve. If these grooves were not closed the brakes would soon leak off after they are applied.

58. Q. Why should the piston travel not more than eight inches?

A. Because if it travels further than this a little wear of the brake shoes will cause the piston to travel far enough to rest against the back cylinder head, when the brakes are applied, and this cylinder head would then take the pressure instead of its being brought upon the brake shoes.

59. Q. How far should the driver brake piston travel with a full application of the brakes, and why?

A. Not less than one-third of the full stroke of the piston nor more than two-thirds of its full stroke, for reasons similar to those given for cars and tenders.

60. Q. If the brakes stick upon any car so that the engineman cannot release them at any time, how are you to release them?

A. By opening the release cock in the auxiliary reservoir, and holding it open until air begins to escape from the triple valve, and then closing it again.

61. Q. What is the pressure retaining valve, and what is its use?

A. The pressure retaining valve is a small valve placed at the end of a pipe from the triple valve, through which the exhaust takes place from the brake cylinder. It is used to retard the brake release on heavy grades and hold the brakes partially applied, so as to allow more time for the engineman to recharge the auxiliary reservoir.

62. Q. What precautions are necessary on every train in regard to hose couplings?

A. Every train must carry at least two extra hose and couplings complete, for use in replacing any hose couplings, which may fail or become displaced. These extra hose and couplings to be carried on such part of the train as is required by the rules and regulations.

SPECIAL FOR ENGINEMEN.

63. Q. How should the air pump be started?

A. It should be started slowly, so as to allow the condensation to escape from the steam cylinder, and prevent pounding, which is more likely to occur when the air pressure is low.

64. Q. Why should the piston rod on the air pump be kept thoroughly packed?

A. To prevent condensation in the steam cylinder from running down the rod into the air cylinder, and thus getting water in the air-brake service.

65. Q. How should the steam cylinder of the air pump be oiled, and what kind of oil should be used?

A. It should be oiled as little as necessary through a sight feed lubricator, and cylinder oil should be used.

66. Q. How should the air cylinder of the air pump be oiled; what kind of oil, and why?

A. It should be oiled very little, by once filling the oil-cup with West Virginia well oil daily. The oil must never be introduced through the air inlet ports, as this practice would cause the valves to gum up.

67. Q. What regulates the train-pipe pressure?

A. The pump governor.

68. Q. At what pressure in the train-pipe must the pump governor stop the pump, and do you understand the importance of keeping this pump governor in order and operating at that pressure?

A. It must stop the pump at a pressure of 70 pounds in the train-pipe, and it must be kept clean and adjusted to this pressure in order to get the best service from the air brakes.

69. Q. Why is the equalizing engineer's valve better than the older forms?

A. Because it enables the engineer to apply the brakes more uniformly throughout the train and with less shock to the train, especially when the quick-acting triple valves are used. It also prevents the brakes from being kicked off on the forward end of the train when the engineer closes the valve.

70. Q. Why does the equalizing engineer's valve produce these results in ordinary service stops?

A. Because the engineer does not, in such cases, open the train-pipe to the atmospere direct, but he only reduces the air pressure above the piston in the engineer's valve, which causes that piston to open the train-pipe to the atmosphere, and to close the opening gradually when the train-pipe pressure has been correspondingly reduced.

71. Q. What does the excess pressure valve in the engineer's valve accomplish, and do you regard it as important to have it working properly?

A. It maintains an excess pressure of about 20 pounds in the main

reservoir above the pressure in the train-pipe, and it is important that it be kept clean and in working order so as to have this excess pressure to insure release and for use in recharging the train quickly after the brakes are released.

72. Q. How often should the brake valve be thoroughly cleaned and oiled?

A. At least once every two months.

73. Q. If the rotary disc valve in the engineer's valve is unseated by dirt or by wear, what may be the result, and what should be done?

A. It may be impossible to get the excess pressure; when the brakes have been applied they may keep applying harder until full on, or when they have been applied they may go off. The rotary disc valve should be thorougly cleaned, and if worn it should be faced and ground to a seat.

74. Q. If the piston in the engineer's valve becomes gummed up or corroded from neglect to clean it, what will be the result?

A. It will be necessary to make a large reduction of pressure through the preliminary exhaust port before the brakes will apply at all, and then the brakes will go on too hard and will have to be released.

75. Q. When the engine is standing alone and the pump is running, why must the engineer's valve not be left standing in the lap position (No. 3)?

A. Because the main reservoir pressure may become so high that, when the handle of the engineer's valve is again placed in the release position, it will cause the train-pipe and tender auxiliary reservoir to be charged with too high pressure which might injure the adjustment of the pump governor as well as cause the tender wheels to be slid with the first application of the brakes.

76. Q. When the engine is coupled to the train, why is it necessary to have the full train-pipe pressure and the excess pressure on the main reservoir?

A. So that the brakes will all be released and the train quickly charged when the engineer's valve is placed in the release position.

77. Q. When the train is charged, and the train-pipe pointer of the air gauge begins to rise, how must you test the train-pipe for leaks?

A. By placing the handle of the brake valve in the lap position, and by observing whether the black pointer stands still or falls back. The more rapidly it falls back the greater is the leak indicated.

78. Q. Why should the driver brakes always be operated automatically with the train brake?

A. Because it adds greatly to the braking force of the train and the brakes can be applied alike to all the wheels for ordinary stops, and in an emergency the greatest possible braking force is at once obtained by one movement of the handle.

79. Q. In making a service application of the brakes, how much reduction of the train-pipe pressure from 70 pounds does it require to get the brakes full on?

A. About 20 pounds reduction.

80. Q. What should the first reduction be in such an application, and why?

A. From six to eight pounds so as to insure moving the pistons in the brake cylinders past the leakage groove, yet not apply the brakes too hard until the slack in drawbars and drawsprings is first taken up.

81. Q. What is the result of making a greater reduction of pressure than 20 pounds?

A. A waste of air in the train-pipe, without getting any more braking force, and therefore requiring more air to release the brakes.

82. Q. How many applications of the brakes are necessary in making a stop?

A. Generally only one; by applying them lightly at first with six or eight pounds reduction of air in the train-pipe, and afterward gradually increasing the force of the application. Two applications are as many as should ever be required.

83. Q. Why is it dangerous to apply and release the brakes repeatedly in making stops?

A. Because every time the brakes are released the air in the brake cylinder is thrown away, and, if it is necessary to apply them again before sufficient time has elapsed to recharge the auxiliary reservoirs, the application of the brakes will be weak, and after a few such applications the brakes are almost useless on account of the air having been exhausted frcm the auxiliary reservoirs.

84. Q. In releasing and recharging the train, how long should the handle of the engineer's valve, be left in the release position?

A. Until the train-pipe pressure has risen nearly to 70 pounds again.

85. Q. In making service stops why should you release the brakes a little before coming to a full stop?

A. So as to prevent stopping with a lurch; it also requires less time for the full release of the brakes after stopping.

86. Q. In making service stops, why must the handle of the engineer's valve not be moved past the position for service applications?

A. So as to prevent unneccessary jerks of the train, and the emergency action of the triple valve when not necessary.

87. Q. If you find the train dragging from the failure of the brakes to release, how can you release them?

A. By placing the handle of the engineer's valve in the running position until full excess pressure is attained, and then throwing it quickly into the release position.

88. Q. When the brakes go on suddenly when not operated by the engineer's valve, and the gauge pointer falls back, what is the cause, and what should you do?

A. Either a hose has bursted, or a conductor's valve has been opened, or the train has parted. In any event, the handle of the engineer's valve must be immediately placed in the lap position to prevent the escape of air from the reservoir.

89. Q. Are the brakes liable to stick on after an emergency application, and why?

A. The brakes are harder to release after a severe application, because they are on with full force, and it requires higher pressure than usual in the train pipe to release them again. In this case it is necessary always to have in reserve, the excess pressure on the main reservoir to aid in releasing the brakes. With the quick-acting triple valve this is especially necessary, because air from the train pipe as well as from the auxiliary reservoir is forced into the brake cylinder when a quick application of the brake is made, thus increasing the pressure in the brake cylinder, and requiring a high pressure in the train pipe afterward to cause the brakes to be released.

90. Q. In using the brakes to steady the train while descending grades, why should the air pump throttle be kept well open?

A. So that the pump may quickly accumulate a full pressure in the main reservoir for use in recharging the train when the brakes have been released again.

91. Q In descending a grade how can you best keep the train under control?

A. First, by commencing the application of the brakes early, so as to prevent too high a rate of speed being reached. Second, by applying the brakes lightly at first, then increasing the brake pressure as needed, and by slowing the train down just before it is necessary to release the brakes for recharging, so as to give them time enough to refill the auxiliary reservoirs before much speed is again attained.

92. Q. If the train is being drawn by two or more engines, upon which engine should the brakes be controlled, and what must the enginemen of the other engines do?

A. The brakes must be controlled by the leading engine, and the enginemen of the following engines must close the cock in the train-pipe just below the engineer's valves. The latter must always keep his pump running and in order, and the main reservoir charged, with the engineer's valve in the running position, so that he may quickly operate the brakes if called upon to do so.

93. Q. If the air-signal whistle only gives a weak blast what is the probable cause?

A. Either the reducing valve is out of order so that the pressure is less than 25 pounds or the whistle itself is filled with dirt.

94. Q. If the reducing valve for the air signal is allowed to become clogged up with dirt, what will the result probably be?

A. The signal pipe might get the full main reservoir pressure, and the whistle will blow when the brakes are released.

95. Q. If you discover any defect in your air brake or signal apparatus while on the road, what must you do?

A. If it is something that cannot be readily remedied at once, it must be reported to the engine-house foreman as soon as the run is completed.

96. Q. What is the result if water be allowed to collect in the main reservoir of the brake apparatus?

A. The room taken up by the water reduces the capacity for holding air, and the brakes are more liable to stick. In cold weather also the water may freeze and prevent the brakes from working properly.

SPECIAL FOR ENGINE REPAIRMEN.

97. Q. How often must the air brake and signal apparatus on locomotives be examined?

A. After each trip.

98. Q. Under what pressure must it be examined?

A. Under full pressure, *i. e.*, 70 lbs. on the air brake train pipe, 20 lbs. excess in the main reservoir and 25 lbs. pressure upon the air-signal train pipe.

99. Q. How will you be sure that proper pressures are upon the two train pipes?

A. By regulating, and, if necessary, cleaning the pump governor so that it will shut off steam from the pump when 70 pounds train-pipe pressure is reached, and by examining, and, if necessary, cleaning the pressure reducing valve for the signal train pipe, so that it maintains 25 pounds pressure in the train pipe.

100. Q. If you do not obtain 20 pounds excess pressure in the main reservoir when the handle of the engineer's valve is in the running position what is the cause?

A. Either the excess pressure valve needs cleaning, or the rotary disk valve in the engineer's valve is unseated and allows air to leak from one port to another.

101. Q. Why must the air-pump piston rod be kept well packed?

A. To prevent condensation in the steam cylinder from running down into the air cylinder and getting into the brake service.

102. Q. How often must the main reservoir and the drain cup under the tender be drained?

A. After each trip.

103. Q. How often must the triple valves and the cylinders of the driver and tender brakes be cleaned and oiled?

A. They must be thoroughly cleaned and oiled with a small amount of well oil once every six months, and the cylinders must be oiled every three months, If the driving-brake cylinders are so located that they become hot from the boiler, they may require oiling more frequently.

104. Q. If there are any leaks in the pipe joints or anywhere in the apparatus, what must you do?

A. Repair them before the engine goes out.

105. Q. How is the brake-shoe slack of the cam-driver brake taken up, and what precautions are necessary?

A. By means of the cam screws, and it is necessary to lengthen both alike, so that when the brake is applied the point of contact of the cams will be in a line with the piston rod.

106. Q. How is the brake-shoe slack of driver brakes on a locomotive with more than two pairs of driving wheels taken up?

A. By means of a turn-buckle or screw in the connecting rods.

107. Q. How is the slack of the tender-brake shoes taken up?

A. By means of the dead truck levers: if they will not take it up enough, it must be taken up in the underneath connection, and then adjusted by the dead lever.

108. Q. What travel of piston should the driver brakes be adjusted for?

A. For not less than one-third nor more than two-thirds of the full stroke of the piston.

109. Q. What travel of piston should the tender brakes be adjusted for?

A. Not less than four inches nor more than eight inches.

SPECIAL FOR TRAINMEN.

110. Q. How should you proceed to test the air brakes before starting out, or before descending a heavy grade?

A. After the train has been fully charged with air, the engineman must be signaled to apply the brakes; when he has done so, the brakes must be examined upon each car to see that the air is applied, and that the piston travel is not less than four inches nor more than eight inches. The engineman must be then signalled to release the brakes, and this signal must be given by the train air signal from the rear car, if it is in use upon the train; after he has done so, each brake must be examined again to see that all are released. The engineman and conductor must then be notified that the brakes are all right, if they are found so.

111. Q. In starting out a passenger train, how many cars must have the brakes in service?

A. Every car upon the train.

112. Q. When might you cut out a brake upon a passenger car?

A. Never; unless it gets out of order while on the run, in which case it must be reported to the inspector at the end of the run, or upon the first opportunity which may give sufficient time to repair it.

113. Q. If a hose bursts upon the run what must be done?

A. The hose must be replaced by a good one, and the engineman then signaled to release the brakes. The train must not proceed until the brakes have been reconnected and tested upon the train to see that all are working properly.

114. Q. If the train breaks in two, what must be done?

A. The cock in the train pipe at the rear end of the first section must be closed, and the engineman signaled to release the brakes. The two parts of the train must then be coupled, the hose connected and the brakes again released by the engineman. After the train has been completely coupled up and the brakes are released, all brakes must be tested before continuing the run.

115. Q. Explain how the pressure-retaining valves are thrown into action or thrown out of action, and when this must be done?

A. The pressure-retaining valve is thrown into action by turning the handle of the valve to a horizontal position, and it is thrown out of action again by placing this handle in a vertical position pointing downward. This handle should be placed in a horizontal position at the top of a heavy grade, and it should always be returned to a vertical position at the foot of the grade, as otherwise the brakes will drag on any cars which still have the handle of the pressure-retaining valve in the horizontal position.

116. Q. If the brake of any car is found to be defective on the run, how should you proceed to cut it out?

A. By closing the cock in the cross-over pipe of the quick-acting brake, or in the triple valve of the plain automatic brake, and then opening the release cock in the auxiliary reservoir upon that car until all the air has escaped from it.

117. Q. What is the conductor's valve, and what is its use?

A. It is a valve at the end of the branch pipe leading from the train-brake pipe upon each car; it is to be opened from the car in any emergency when it is necessary to stop the train quickly, and only then. When used it should be held open until the train is stopped, and then it should be closed.

118. Q. What is the air signal for, and how is it operated?

A. It is to signal the engineman, in place of the old gong signal, and it is operated by pulling directly downward on the cord one second for each signal given and allowing two seconds to elapse between pulls.

119. Q. If the car discharge valve on the air-signal system is out of order or leaking on any car how can you cut it out?

A. By closing the cock in the branch pipe leading from the train signal-pipe to the discharge valve; to do so the handle of this cock should be placed lengthwise with the pipe.

120. Q. How is the slack taken up so as to secure the proper adjustment of piston travel?

A. By means of the dead truck lever, and if that is not sufficient, one or more holes must be taken up in the underneath connection and the adjustment then made by the dead truck lever.

SPECIAL FOR INSPECTORS.

121. Q. Do you understand that no passenger train may be started out with any of the brakes cut out of service?

A. I do.

122. Q. Why is it important that no leaks should exist in the air-brake service?

A. Because they would interfere with the proper working of the brakes and might cause serious damage.

123. Q. What must be done with the air brake or air-signal couplings when not united to other couplings?

A. They must be secured in the dummy coupling, so that the face of the dummy coupling will cover the opening of the hose coupling so as to prevent dust and dirt from entering the hose.

124. Q. If air issues from the release port of the triple valve when the brakes are off, what is the cause?

A. It is probably due to dirt on the rubber-seated emergency valve.

125. Q. How often must the cylinder and triple valves be examined, cleaned and oiled?

A. Once every six months, and the cylinders must be oiled once every three months with a small quantity of well oil. The dates of the last cleaning and oiling must be marked with chalk on the cylinders.

126. Q. To what travel of piston must the brakes be adjusted?

A. Not less than four inches nor more than eight inches.

127. Q. How is the slack taken up so as to secure this adjustment?

A. By means of the dead truck lever, and if that is not sufficient one or more holes must be taken up in the underneath connection and the adjustment then made by the dead truck lever.

128. Q. What are the different holes in the outer end of the cylinder levers for, and why must the connections be pinned to the proper hole for each car?

A. These holes are to enable the adjustment of the brake pressure to be made according to the weights of different cars. The connection must be made to the proper hole in each case, according to the weight of the car, so as to give proper braking power, otherwise the brake will be inefficient, or the wheels may be slid under the cars.

DISCUSSION ON AIR BRAKE RULES.

On motion the report was received.

MR. GIBBS—The question of adopting the rules governing employees in the use of air brakes was the subject of some discussion in the Master Car Builder's Convention, and they were not adopted there as a standard, but ordered to be placed on file for the use of the members, and the committee

was continued. They argued that the rules would be probably subject to revision. There was considerable discussion in regard to some of them. It would seem desirable to take action similar to that of the Master Car Builders' Convention—to place the rules on file for use of the members as they see fit. I make that as a motion.

SECRETARY SINCLAIR—Mr. President does that motion imply that the rules will be printed separately from the annual report, or merely incorporated in the annual report?

MR. GIBBS—It was proposed in the Master Car Builders' Association to print them something like the rules of interchange, but that motion was not put or carried.

SECRETARY SINCLAIR—I may say, for the information of members, that they have not decided to print it in separate form. That is left over for the committee, which is continued, and the rules are to be revised and submitted again next year. If the motion covers the action of our printing these rules in our annual report and continuing the committee, it will coincide with the action of the Master Car Builders.

THE PRESIDENT—Did you propose to have this printed in our annual report?

MR. GIBBS—In our annual report and the committee continued.

MR. HICKEY—On the looks of the report from the committee, and the amount of time that they must have spent in getting up the questions and answers, it would seem to me that the continuance of the committee is entirely unnecessary. I do not think that they could improve on the situation. I think that the continuance of those committees should only be permitted under circumstances which make it absolutely necessary. I think these rules should be adopted as they are by the Association. I would like to ask some member of the committee who is here to say something on that question. He might enlighten us.

MR. DAVID CLARK, Lehigh Valley—I do not know that I have anything further to say in regard to this. I met the joint committee once at Buffalo. I doubt whether it is advisable for us to print those rules or pay for printing them in our report. They are already printed and furnished by the Westinghouse Air Brake Company. A number of the members already have a copy of them. At least I have, and I would not recommend going to the expense of printing them and putting them in our report, because we can get them without any expense.

THE PRESIDENT—I would say that the report at the Car Builders' meeting seemed to satisfy many of them there. But Mr. Rhodes pointed out some points that he had investigated and found different on his line and wanted to amend the matter and had it referred back to the Committee for another year. Now I do not believe that this Association should adopt those rules until the adoption of the rules by the Master Car Builders' Association. That is I think they should both go together.

Mr. Hickey—Is it intended by this motion of Mr. Gibbs that the report should be embodied in our annual report?

The President—That was the idea.

Mr. Barnes—This is the most important set of rules that has ever come before this Association and I should think before they are adopted that each and every rule should be read and discussed before the adoption of any one of them.

Mr. Hickey—Then you better not put them in the annual report.

Mr. Barnes—That might be, too.

The President—I presume the members will understand that we are not adopting these rules. The motion is not to adopt the rules but to receive the report and to print the rules in the annual report for the information of the members.

Mr. Gibbs—That is merely a convenient place for having them on file. That is all.

The President—The question now before you is the receiving and filing of the report of the Committee on Air Brakes and the continuing of the committee for another year.

The motion was carried.

SUBJECTS FOR INVESTIGATION AND DISCUSSION.

The President—The next report will be that of the Committee on Subjects for Investigation and Discussion. Is the committee ready to report?

Mr. Lewis—I would state that there seems to be quite a dearth of subjects at this time. In all previous conventions it has required considerable effort to keep the number of subjects down within reasonable limits, so that they could be discussed within the time usually taken by the convention. We find that at this convention there are only three subjects that have been continued—the Coupler Subject, Exhaust Pipes and Nozzles, and Air Brake Rules. One of the members has suggested the subject of Locomotive Indicating. This question came up, as you will remember, yesterday, and there seemed to be quite a diversity of opinion as to the merits or value of locomotive indicating. I think if that subject were put into the hands of a competent committee that they could bring out some valuable information, and I would suggest that as one of the subjects for discussion at our next convention. It was also thought desirable to appoint a committee—a permanent committee—on compound locomotives. The subject was discussed yesterday and an amount of interesting information was brought out.

I would also suggest a standing committee on special tests and investigations. This is in the line of the Committee on Laboratories. As you know, there are a great many phenomena and interesting things that could be considered by such a committee and brought to the notice of the Associa-

tion, similar to that question of bending steel at different temperatures. I think it would be desirable to have a standing Committee on Special Tests and Investigations.

It was also suggested by one of the members that a subject bearing on the uniform practice of compiling locomotive performance would be a desirable thing. We know now that various roads have various information with regard to locomotive performance, and we think that it would be a very desirable thing if a uniform practice could be established.

I would like if any of the members who have any subjects to present would mention them to the committee at this time.

MR. SWANSTON—In our investigations on the standard question I thought it would be well if a Committee on Standards—a new one, not the old one—were appointed to take it up in connection with the United States Screw Threads and Standard Size of Nuts, and it would also take into consideration the correct taper for bolts through frames.

THE PRESIDENT—Through any hole?

MR. SWANSTON—Through any hole; but holes through frames particularly. I think that subject might be taken up. There is one point occurred to me—a good many of us buy taps. We have a limit gauge for iron. We buy our tap, which is made to the gauge exactly. Every time it is used there is a reduction. How far that reduction should be, is a matter of opinion with the men that are using it. Now we know that the limit gauge is above and below that size, and the question for this committee would be how far that should go. There are a great many interesting questions connected with that matter, and I think a committee on that subject might give us some very good information.

THE PRESIDENT—Do the committee see fit to endorse that in their report?

MR. WEST—If I may be allowed, I would like to add the best method and practice of setting flues in locomotive boilers.

MR. LEWIS—I hardly think there is enough in the subject to justify making that a permanent subject. I think, however, that much information could be obtained by bringing that up under subjects at the noon hour.

MR. GIBBS—As I suggested that subject on locomotive indicating, I think it might be widened, in the way Mr. Lewis stated it, to advantage. The American Society of Mechanical Engineers appointed a Committee on a Standard Method of Tests for locomotives—some such title as that—by which tests they meant a complete test of the locomotive as a machine on the road, as a steam user and as a medium for burning coal and generating steam. Now if this Association, as representing the practice of the country in the use of those machines, would express its opinion as to whether such a test were feasible, and if so, the best line on which to conduct it, it might add weight to any recommendation they would make.

MR. BARNES—That Committee on Locomotive Performance might be included in that. Make it all one committee, and give them plenty to do.

THE PRESIDENT—Is there anything else to add to the committee? If not, the committee will hand in the report so that the Secretary can read it.

The next order of business will be the reading of papers and discussing of questions propounded by members. Under that head I would call on the Committee on Resolutions to report.

RESOLUTIONS.

Secretary Sinclair read the following resolution, reported by the Committee on Resolutions:

"*Resolved*, That the cordial thanks of this Association be tendered to Senator Rayburn for his address of welcome to our Twenty-fourth Annual Convention; to Rev. George Royal, for his services as Chaplain; to the various committees of our commercial friends for their efforts to entertain the members and their ladies; to the officers of the year, who have been so untiring in their efforts to increase the membership and widen the influence of the Association; and to the *Northwestern Railroader* for publishing our reports in daily form.

On motion of Mr. Hickey, the resolution was adopted by a rising vote.

THE PRESIDENT—Has any member any paper or question that he wishes to propound to the Convention?

If not, we will proceed to the next order of business, which is Routine and Miscellaneous business.

COMMITTEE ON SUBJECTS FOR DISCUSSION.

I will first announce the Committee on Subjects for Discussion at the next annual meeting: J. Davis Barnett, chairman; George Gibbs and William Smith, of the Chicago & Northwestern.

ELECTION OF OFFICERS.

THE PRESIDENT—The next order of business, gentlemen, is that of the election of officers. I will appoint Mr. Tandy and Mr. Peck as tellers. Gentlemen, you will prepare your ballots for President.

The Convention then proceeded to ballot for President with the following result: Fifty-three votes were cast, of which number John Mackenzie received 33, John Hickey 13, J. H. Setchel 3, James Meehan 2, William Swanston 1, J. M. Lauder 1.

MR. SETCHEL—I move that the vote be made unanimous.

The motion was put by Mr. Hickey and carried unanimously by a rising vote

THE PRESIDENT—I presume that a speech is not in order now on account of the limited time we have, but I will write you a letter about it. I must say this, before announcing another ballot, that the attendance has been remarkably large, the interest has been certainly greater than ever I have seen in the Association, after seventeen years of membership, and at no time have I ever attended a Convention where we have been able to get the members together so quickly in the morning. We had our photographs taken this morning and were in here and at work at fifteen minutes past nine. Whether the members consider that it is the members or the President that run this Convention, I don't know; but I think it is the members, and I cannot refrain from giving them my hearty thanks for the support I have had during the entire Convention.

Gentlemen, you will prepare your ballots for First Vice-President.

The Convention balloted for First Vice-President. Fifty-one votes were cast—43 for John Hickey; the others scattering:

On motion of Mr. Peck the election of John Hickey as First Vice-President was made unanimous by a rising vote.

MR. HICKEY—Mr. President and gentlemen: I accept the election with the honor and responsibility which it implies. I hope and trust that Mr. Mackenzie and myself and the other officers whom you choose will hand this Association over to our successors with the same record, in the same state of prosperity, with which it has come into our hands. I trust and hope that every one will again contribute this coming year to the success of the organization so that we will be looked upon as an authority not only the mechanical minds of this country but of all other civilized countries. Gentlemen, I thank you. (Applause.)

The ballotting for Second Vice-President resulted as follows: Fifty-two votes were cast—45 for William Garstang; the rest scattering.

On motion of Mr. Lauder the election of Mr. Garstang was made unanimous by a rising vote.

MR. GARSTANG—Mr. Chairman and members of this Association: I fully concur in the remarks made by our First Vice-President, who has covered my feelings on the subject thoroughly, and I do not know that I could say anything more.

The Convention then ballotted for Treasurer. Fifty-one votes were cast—45 for O. Stewart and 6 scattering.

On motion of Mr. Setchel the election of Mr. Stewart was made unanimous by a rising vote.

MR. STEWART—Mr. President and gentlemen of the Convention: I thank you for your renewed confidence expressed in me to-day in handling the funds of the Association, and I accept the arduous duties and promise to fulfill them faithfully.

The Convention ballotted for Secretary. Fifty-two votes were cast—49 being for Angus Sinclair and 3 for J. H. Setchel.

On motion of Mr. Setchel the election of Mr. Sinclair, as Secretary, was made unanimous by a rising vote.

AUXILIARY COMMITTEE ON COMPOUND LOCOMOTIVES.

THE PRESIDENT—One of the things that I wish to suggest is this—that each of the locomotive manufacturers of this country be allowed to name a member of the committee on compound locomotives—one from each locomotive manufactory—to act in conjunction with the regular committee of this association. If the members see fit a motion to that effect will be entertained.

MR. SETCHEL—How large should we make the committee.

THE PRESIDENT—Probably eight or ten.

MR. SETCHEL—Then I would move you that the President of the Association invite the locomotive builders of the country who desire to do so, to nominate one person to act with this committee on compound locomotives. The person nominated should be a member of this Association of course.

The motion was carried.

MR. LAUDER—There seems to be some little misunderstanding about the vote just cast, as to whether each locomotive builder has the privilege of naming a member to represent him on this committee. Is that the way it is understood ?

THE PRESIDENT—That is the way I understand the question.

PREFERENCE FOR NEXT PLACE OF MEETING.

THE PRESIDENT—There is one more matter I would like to bring to your attention. Of course you understand that the selection of the place of meeting is now in the hands of the Executive Committee of this Association, in connection with the Executive Committee of the Master Car Builders' Association. I think it is due the Executive Committee that you give a expression of your preference for the place of meeting. We do not seem to have any communications on the table from any of the different places where we have been going or would like to go.

MR. LAUDER—I think, Mr. President, that the various hotels at the different places that have sent communications to the Master Car Builders' Association would also have had a communication to present to this Association had they thought it necessary. I know, I presented a communication from the proprietor of the hotel at Cottage City, Martha's Vineyard, offering us good rates if we would meet there next year. That communication is in the hands of the Master Car Builders' Association. Now, I presume that all these others are exactly in the same condition, and under the circumstances it does not seem to me that we can very well vote on a place understandingly, and I think it is better to leave it to the committee. I only make this state-

ment to show why we have not been honored with requests from those hotel keepers. Newport, Saratoga and other places have been mentioned.

A ballot was taken.

SECRETARY SINCLAIR—Forty-five have voted—13 for Saratoga, 1 for New York, 4 for Denver, 6 for Martha's Vineyard, 1 for Niagara Falls, 1 for Boston, 11 for Montreal, 1 for Waukesha, 1 for Newport, 1 for Pittsburg, 1 for Chautauqua and 3 for Narragansett. The highest three are Saratoga, Montreal and Martha's Vineyard.

MR. LAUDER—I have only this to say with reference to Martha's Vineyard, or more properly speaking, Cottage City, on Martha's Vineyard. Martha's Vineyard is an island off Cape Cod, reached by all the roads, and a steamboat right from Woodshall or New Bedford. There is plenty of hotel room and it is a beautiful place. An excursion could easily be arranged from there over to Nantucket, and while personally I do not want you to go there, for it means a good deal of work for me, if you choose to go there, we will take good care of you.

ADJOURNMENT.

THE PRESIDENT—There seems to be no further business to be brought before this Convention and a motion to adjourn is in order. I would say before adjourning, that if you gentlemen will give the support to the officers in the coming year that you have in the past year, we will make a gain of not only ninety-five, but of one hundred and ninety-five. We have had one of the most pleasant conventions I have ever attended. I certainly cannot adjourn this meeting without again saying I thank you heartily. Gentlemen, a motion to adjourn is in order.

On motion the convention adjourned.

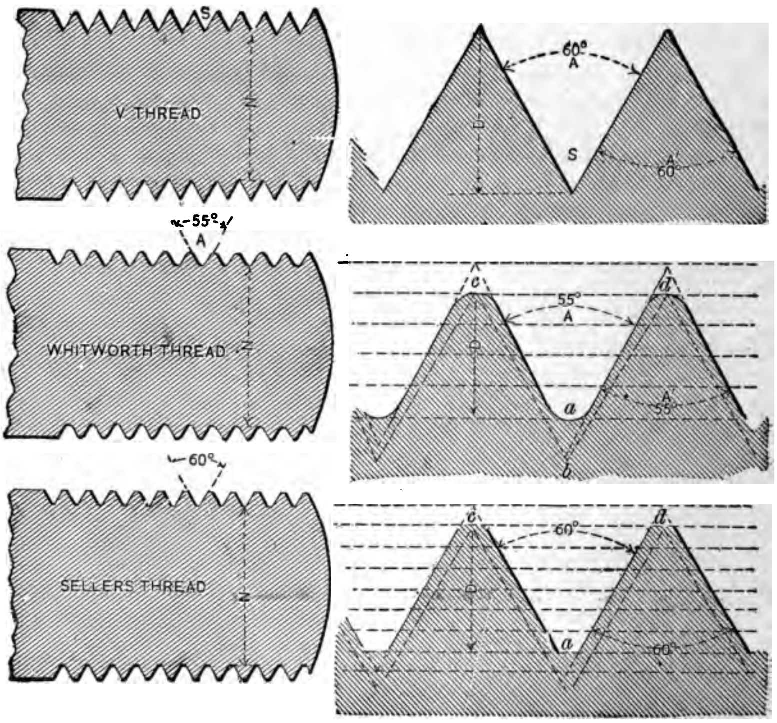
STANDARDS ADOPTED

BY THE

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

SCREW THREADS.

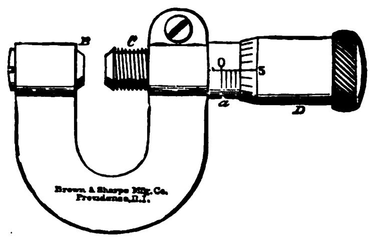
At the Third Annual Convention the report of a committee recommending the United States Standard Screw Thread was adopted. Annexed are the forms and dimensions of the threads in question.



Screw Threads. Sellers' Standard.

SHEET METAL GAUGE.

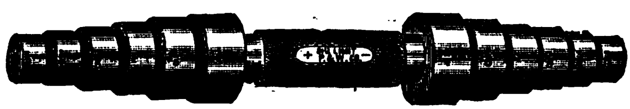
At the Fifteenth Annual Convention the Brown & Sharp micrometer gauge shown below was adopted as standard for the measurement of sheet metal.

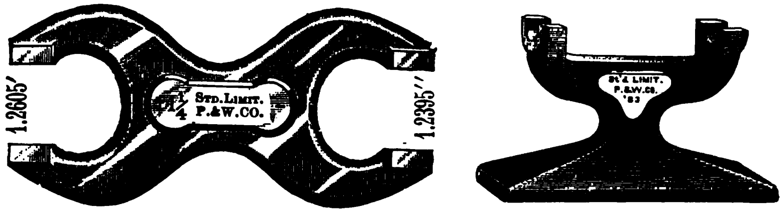


LIMIT GAUGES.

At the Seventeenth Annual Convention the Pratt & Whitney limit gauges for round iron, illustrated on this and following page, were adopted. The sizes are as follows :

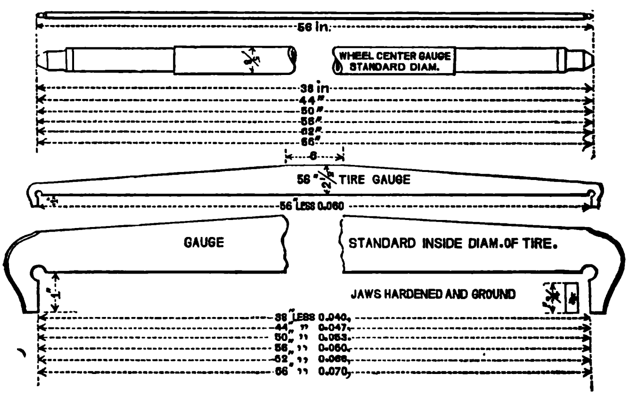
Nominal Diameter. Of Iron. Inches.	Large size. + end. Inches.	Small size. — end. Inches.	Total variation. Inches.
1/4	.2550	.2450	.010
5/16	.3180	.3070	.011
3/8	.3810	.3690	.012
7/16	.4440	.4310	.013
1/2	.5070	.4930	.014
9/16	.5700	.5550	.015
5/8	.6330	.6170	.016
3/4	.7585	.7415	.017
7/8	.8840	.8660	.018
1	1.0095	.9905	.019
1 1/8	1.1350	1.1150	.020
1 1/4	1.2605	1.2395	.021





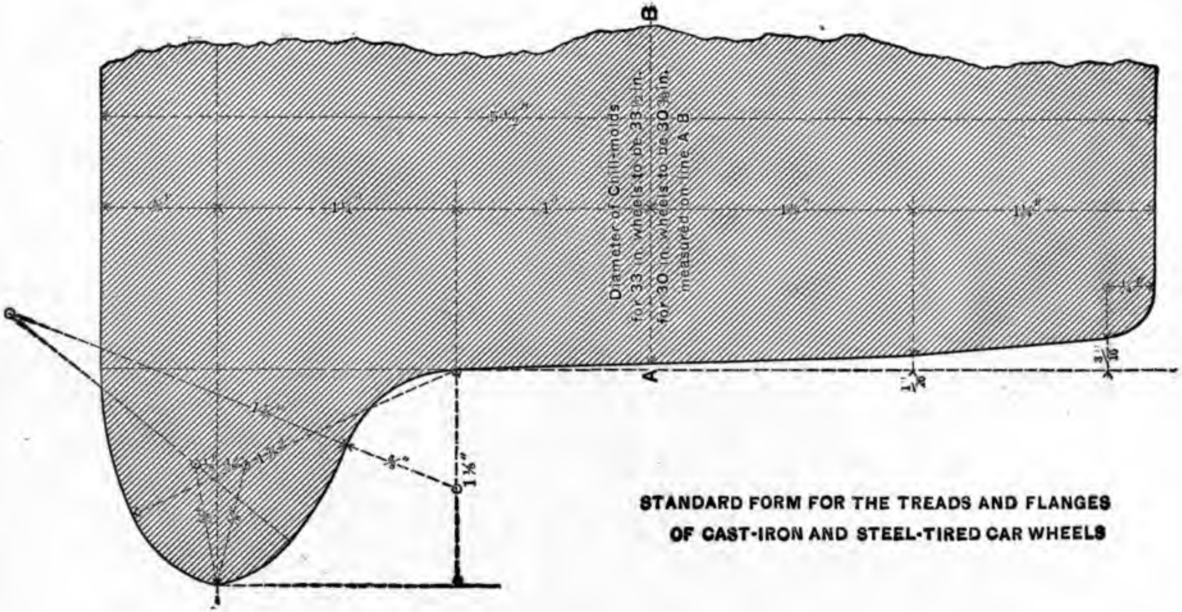
DRIVING WHEEL CENTRES AND SIZE OF TIRES.

At the Nineteenth Annual Convention the report of a committee was adopted which recommended driving wheel centres to be made 38, 44, 50, 56, 62, or 66 inches diameter. At the Twentieth Annual Convention the recommendations of a committee were adopted making tire gauges manufactured by Messrs. Pratt & Whitney, Hartford, Conn., and here illustrated, standards of the Association. The sizes and the allowance for shrinkage are as follows:



SECTION OF TIRE.

At the Twentieth Annual Convention the standard form of tire section adopted by the Master Car Builders' Association was adopted as the standard of this Association. Annexed engraving, on page 201, gives particulars of the standard.



STANDARD FORM FOR THE TREADS AND FLANGES OF CAST-IRON AND STEEL-TIRED CAR WHEELS

OBITUARY.

S. M. CUMMINGS.

Samuel Mason Cummings was one of the original members of the American Railway Master Mechanics' Association, and was made an honorary member in 1885.

He was born at Rehoboth, Bristol county, Massachusetts, in 1816, and was educated in the public schools of that county. At an early age he was at work in a machine shop. In 1837 he commenced work in the machine shop of the Boston & Worcester Railroad at Boston, where he was employed until 1845, when he entered the service of the Old Colony Railroad Company as foreman of the shops, and was afterward Master Mechanic. In the Fall of 1850 he resigned to take a position at the Boston Locomotive Works. In the Spring of 1852 he was appointed Master Mechanic of the Michigan Southern & Northern Indiana Railroad, remaining there till 1856, when he was appointed Master Mechanic of the Western Division of the Pittsburgh, Fort Wayne & Chicago Railway. He was afterward transferred to the Eastern Division, where he remained until July, 1877, when he resigned on account of illness, and retired from active service and removed to Boston, where he died after a long and painful sickness, May 6th, 1891, leaving a widow with whom he had traveled on the journey of life forty-eight years.

Quiet and unassuming, faithful to every trust, he left a host of real friends. Cheerful and patient under the long and severe affliction, he never complained. If one word of his many, many friends would bring him back, who would speak it?

GEO. RICHARDS,
J. N. LAUDER,
JOHN THOMPSON,
Committee.

S. B. TINKER.

S. B. Tinker, Master Mechanic of the Cincinnati, Wabash & Michigan Railway, died of pneumonia at his home at Wabash, Indiana, in April last. Mr. Tinker, like many others of our railroad officers, pushed himself up from a humble beginning, with no help but his own unaided exertions, to a prominent and honorable position. At the early age of eleven years he was thrown upon his own resources for making a livelihood. He went to work in a blacksmith shop, where he continued for five years, and then entered a shop to learn the machinist trade. In 1854 he began railroad work as a locomotive engineer and followed the business for twenty-one years, gaining experience on various roads in New York, Michigan and Ontario. In 1875 he was appointed Master Mechanic of the Chicago & Lake Huron, which he left two years later to accept the position of Master Mechanic of the Cincinnati, Wabash & Michigan, which he held at the time of his death. He joined the Railway Master Mechanics' Association in 1887.

Mr. Tinker was extremely popular with the men under his charge, and he was a faithful, painstaking and conscientious railroad officer. Besides a host of personal friends, he left a wife and two daughters to mourn his loss.

ANGUS SINCLAIR.

F. E. WORCESTER.

Franklin Eldred Worcester was the fourth son of Edwin D. Worcester and Mary Low Worcester, and was born at Albany, New York, September 12, 1860. His father has been an officer of the New York Central & Hudson River Railroad Company for over thirty years, and is also Vice-President of the Lake Shore & Michigan Southern Railway and of the Michigan Cen-

tral Railroad Companies. Franklin E. Worcester's earlier years were passed in Albany. In 1877 he graduated from the Albany Boys' Academy, the leader of his class. In 1878 he entered Yale College, from which he graduated, in due course, in 1882. He was a conspicuous member of his class, both in the matter of his rank in scholarship and also in the matter of the social and literary honors which are so much coveted by the Yale undergraduate. He was chosen one of the five editors of the Literary Magazine, and was a member of the Skull and Bones Society.

After his graduation from the Academical Department, he entered the Sheffield Scientific School of that university, intending to pursue the profession of civil engineering. In preparation for this, he spent a considerable portion of the summer of 1882, as a member of a party engaged in making the preliminary survey for a railroad in Warren and Venango Counties, Pennsylvania.

His taste for mechanical engineering, however, which he inherited from both sides of his ancestry, soon asserted itself, and he speedily abandoned all further thought of civil engineering. During all the rest of his life he was warmly devoted to his profession as a mechanical engineer. His liking for it extended to all its details, and the considerable proficiency to which he afterwards attained as a practical workman was as great a source of pleasure and pride to him as his acquirements in the theory of the profession. He remained at the Sheffield Scientific School, with a few absences, until the summer of 1885, having received, in 1884, the degree of Ph. B. In 1866, he received from Yale University the further degree of Dynamic Engineer. He spent the latter part of 1883 in Europe, and the summer of 1884 in California. In the autumn of 1885, after finally leaving the School, he became machinist-apprentice in the car-shops of the Michigan Central Railroad Company, at Jackson, Michigan. Here he remained till June, 1887. In the autumn of the same year, in further pursuit of his purpose of improving himself in the practical knowledge of his profession, he acted for several months as locomotive fireman on the Mich-

igan Central Railroad, and also, for a short time, on the Hudson River Divison of the New York Central.

In February, 1886, he was made Assistant Superintendent of Motive Power of the Duluth, South Shore and Atlantic Railroad, with his office at Marquette. At this time he joined the Master Mechanics' Association, in which he took a warm interest. He continued with this road, in that capacity and also during part of the time in charge of its car-shops, until the summer of 1889, when he resigned. During part of the autumn of that year, he acted as inspector of the new breakwater then in course of construction at Marquette by the Federal government. Later in the same autumn (1889), he became traveling salesman for the Iron Bay Company, of West Duluth, engaged in the manufacture of mining machinery, and during the succeeding winter spent most of his time among the mines and furnaces of the Gogebic range. In July, 1890, he was made general agent, for the Montana region, of that company and also of the Robinson & Cary Company, of St. Paul. His new office was at Helena, Montana. Here he lived, very actively engaged in his business, until the day of his death. He died very suddenly, of acute pneumonia, at Helena, March 3, 1891, aged thirty years and five months.

Since 1883 his home had been in New York City, whither his father's family had moved in December of that year. His visits to his home were necessarily at long intervals, and he was just on the point of making such a visit when death came upon him so suddenly. His constitution had always been more than usually hearty and robust, and gave every promise of a long and successful life. His body was brought to this city, and his funeral service was held here, at the house of his parents, March 14, 1891.

Mr. Worcester was a member of the American Society of Mechanical Engineers, and of the Masonic fraternity, and was also a member of the University Club, of this city.

ANGUS SINCLAIR.

COMMITTEES FOR CONDUCTING THE BUSINESS OF THE YEAR 1891–92.

No. 1. Exhaust Pipes, Nozzles and Steam Passages.

C. F. THOMAS,
A. W. GIBBS,
L. S. RANDOLPH,
J. M. WALLIS,
GEO. W. SMITH,
ROBERT QUAYLE,
JOHN Y. SMITH.

No. 2. The Present Status of the Car Coupler Question.

JOHN HICKEY,
G. W. RHODES,
SANFORD KEELER,
R. H. BLACKALL,
M. N. FORNEY.

No. 3. Standard Tests for Locomotives.

To investigate the practicability of establishing a standard system of tests to demonstrate the fuel and water consumption of locomotives. Also to ascertain the value of the steam engine indicated in locomotive tests.

J. N. LAUDER,
J. DAVIS BARNETT,
ALBERT GRIGGS,
JOHN D. CAMPBELL,
F. W. DEAN.

No. 4. Compound Locomotives.

To investigate the relative economy of compound and simple locomotives; also the most valuable form of compound locomotive.

George Gibbs,
William H. Lewis,
Pulaski Leeds,
James Meehan,
T. W. Gentry,
A. T. Woods.

Auxiliary Committee—

S. M. Vauclain, Baldwin Locomotive Works;
Reuben Wells, Rogers Locomotive Works;
H. N. Sprague, Porter Locomotive Works;
A. J. Pitkin, Schenectady Locomotive Works;
Joseph Lythgoe, Rhode Island Locomotive Works;
F. J. Leigh, Canadian Locomotive Works;
D. A. Wightman, Pittsburgh Locomotive Works.

No. 5. Tests of Steel and Iron.

To investigate the critical temperature of steel and iron. Also any other questions relating to steel and iron that the committee may consider of value.

William Smith,
J. N. Barr,
A. W. Quackenbush,
P. H. Peck,
D. L. Barnes.

No. 6. Uniform Locomotive Performance Sheets.

To report on the practicability of establishing a system for recording the performance of locomotives that will fairly represent the work done.

George F. Wilson,
J. S. McCrum,
John Player,
James McNaughton,
John A. Hill.

No. 7. Standard Bolts and Nuts.

To report on the best taper for bolts, and the proper size of nuts, rough and finished. Also to report on accurate measuring gauges.

WM. SWANSTON,
WM. GARSTANG,
T. W. GENTRY,
W. LAVERY,
A. DOLBEER,
L. R. POMEROY.

No. 8. Boilers for High Pressure Locomotives.

J. M. BOON,
H. D. GORDON,
J. S. GRAHAM,
J. H. McCONNELL,
W. H. MARSHALL.

No. 9. Air Brake Standards and Inspection and Care of Air Brakes.

R. C. BLACKALL,
G. W. STEVENS,
DAVID CLARK.

Committee on Subjects for Investigation.

J. DAVIS BARNETT,
GEORGE GIBBS,
WILLIAM SMITH.

Executive Committee.

JOHN MACKENZIE,
JOHN HICKEY,
WILLIAM GARSTANG,
O. STEWART,
ANGUS SINCLAIR.

NAMES AND ADDRESSES OF MEMBERS.

NAME.	ROAD.	ADDRESS.
Addis, J. W.	Texas & Pacific	Gouldsboro, La.
Agnew, J. H.	South Carolina	Charleston, S. C.
Aldcorn, Thos.	West Shore	New Durham N. J.
Ames, L.	Beech Creek	Jersey Shore, Pa.
Arp, W. C.	C., St. L. & P.	Logansport, Ind.
Atkinson, R.	Canadian Pacific	Montreal, Que.
Augustus, W.	Keokuk & Western	Centerville, Ia.
Austin, W. L.	Baldwin Locomotive	Works, Philadelphia, Pa.
Ball, A. W.	N. Y., L. E. & W.	Galion, O.
Barnes, J. B.	Wabash	Springfield, Ill.
Barnett, J. Davis	Grand Trunk	Stratford, Ont.
Barnett, T. E.	Canadian Pacific	Vancouver, B. C.
Barr, J. N.	C., M. & St. P.	Milwaukee, Wis.
Barnum, M. K.	329 Spring	Street, New Albany, Ind.
Battye, John E.	N. & W.	Shenandoah, Va.
Bean, John	C. & Canton	Canton, Ohio.
Bean, S. L.	Northern Pacific	Fargo, N. Dak.
Beckert, Andrew	Louisville & Nashville	Decatur, Ala.
Berry, J. H.	C., C., C. & St. L.	Delaware, O.
Bisset, John	W., W., C. & A.	Wilmington, N. C.
Blackall, R. C.	D. & H. Canal Co.	Albany, N. Y.
Blackwell, Charles	Care of Shoenberger	& Co., Pittsburgh, Pa.
Boatman, F. P.	C., C., C. & St. Louis	Indianapolis, Ind.
Boon, J. M.	West Shore	Frankford, N. Y.
Boyle, Wilson L.	B., B. & W. End	Brooklyn, N. Y.
Bradford, J. C.	Providence & Springfield	Providence, R. I.
Bradley, W. F.	K. & Michigan	Charleston, W. Va.
Bradt, Joseph		Rochester, N. Y.
Brastow, L. C.	C. & New Jersey	Ashley, Pa.
Briggs, R. H.	K. C., M. & B.	Memphis, Tenn.
Brooke, George B.	St. Paul & Duluth	St. Paul, Minn.

NAME	ROAD	ADDRESS
Brown, Angus	Northern Pacific	Livingston, Mont.
Brown, F. R. F.	Dominion Bridge Co.	Montreal, Que.
Brown, J. L.	Pittsburgh & Western	Allegheny, Pa.
Brown, W. A.	Atlantic & Danville	Portsmouth, Va.
Brownell, F. G.		Muncie Street, Muncie, Ind.
Bruce, Frank	Ch. & East. Ill.	Danville, Ill.
Bruck, Henry T.	C. & Penn	Mt. Savage, Ind.
Bryan, H. S.	D. & I. Range	Two Harbors, Minn.
Bryant, J. T.	Rich., Fred., & Potomac	Richmond, Va.
Buchanan, William	N. Y. C. & H. R.	New York, N. Y.
Burns, C. H.	Hous. & Tex. Central	Houston, Tex.
Butterly, T. E	Wabash	Moberly, Mo.
Bushnell, R. W.	B., C. R. & N.	Cedar Rapids, Ia.
Campbell, John	Lehigh Valley	Delano, Pa.
Campbell, John D.	N. Y. Central	West Albany, N. Y.
Carmody, T.	N. Y., P. & O.	Cleveland, O.
Carson, M. T.	Mobile & Ohio	Jackson, Tenn.
Casanave, F. D.	P., Ft. W. & C.	Ft. Wayne, Ind.
Casey, J. J.	L., N. O. & Texas	Vicksburg, Miss.
Chapman, N. E.		251 S. Fourth Street, Philadelphia, Pa.
Chapman, T. L.		120 Broadway, New York.
Clark, David	Lehigh Valley	Hazelton, Pa.
Clark, Isaac W.	C., F. & Y. V.	Fayetteville, N. C.
Clifford, J. G.	Louisville & Nashville	Mobile, Ala.
Cloud, John W.		Rookery Building, Chicago, Ill.
Cockfield, William	Mexican Central	Jimulco, Mexico.
Collier, M. L.	Western & Atlantic	Atlantic, Ga.
Collinson, James	Atchison, Top. & S. F.	Fort Madison, Ia.
Conolly, J. J.	D., S. S. & A.	Marquette, Mich.
Cooper, Charles J.	C., S. & Mackinaw	East Saginaw, Mich.
Cooper, H. L.		4412 Wabash Avenue, Chicago, Ill.
Cooke, Allen		Danville, Ill.
Cook, John S.	Georgia	Augusta, Ga.
Cory, C. H.	C., H. & D.	Lima, O.
Cromwell, A. J.	Baltimore & Ohio	Baltimore, Md.
Cullen, James	N., C. & St. L.	Nashville, Tenn.
Curran, Peter	N. Y., L. E. & W.	Bradford, Pa.
Cushing, G. W.		P. O. Box 336, Chicago, Ill.
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Davies, J. M.	Chateaugay	Lyon Mountain, N. Y.
Davis, James A.	N. T. & Q.	Deseronto, Ont.

NAME	ROAD	ADDRESS
Deems, J. T.	Chi., Bur. & Quin.	Ottumwa, Ia.
Deibert, F. W.	Cin., J. & M.	Marshall, Mich.
Derby, R.	South Florida	Sanford, Fla.
Dickson, G. L.	Dickson Locomotive Works, Scranton, Pa.	
Dickson, J. P.	Dickson Locomotive Works, Scranton, Pa.	
Dolbeer, Alonzo	B, R. & Pittsburgh	Rochester, N. Y.
Domville, C. K.	Grand Trunk	Hamilton, Ont.
Downe, George	Government	Sidney, N. S. Wales.
Downing, T.	El., Jol. & Eastern	Joliet, Ill.
Durrell, D. J.	Illinois Contral	Chicago, Ill.
Eastman, A. G.		Sutton, Que.
Eddy, W. H.	Boston & Albany	Springfield, Mass,
Elliott, Henry		East St. Louis, Ill.
Ellis, Matt.	C., St. P., M. & O.	St. Paul, Minn.
Ennis, W. C.	N. Y., S. & W.	Wortendyke, N. J.
Ettinger, G. T.		New York.
Evans, Edward	Balt., O. and S. Western	Chillicothe, Ohio.
Fenwick, A.	G. B., W. & St. P.	Green Bay, Wis.
Ferguson, G. A.	Concorn & Montreal	Lake Village, N. H.
Ferguson, Z. J.		
Ferry, F. J.	Louisville, St. L. & Tex.	Cloverpont, Ky.
Finlay, L.	902 West Fourth Street, Little Rock, Ark.	
Flahaven, W. M.	P. & W.	Allegheny, Pa.
Forsyth, William	C., B. & Q.	Aurora, Ill.
Foster, W. A.	Fall Brook Coal Co.	Corning, N. Y.
Foulks, John	I., St. L, & K. C.	Charleston, Ill.
Fowle, I. W.	Colorado Midland	Leadville, Col.
Fraser, T. A.	Wells & French Car Works, Chicago, Ill.	
Fuller, C. E.	N. Y., L. E. & W.	Jersey City, N. J.
Fuller, William	213 Kennard Street, Cleveland, Ohio.	
Galbraith, R. M	St. L., A. & Tex.	Tyler, Tex.
Galloway, A.	T. A. A. & N. H.	Owosso, Mich.
Garlock, W. H	S. L. S. & E.	Seattle, Wash.
Garrett, H. D	Pennsylvania	Philadelphia, Pa.
Garstang, Wm	Ches. & Ohio	Richmond, Va.
Gentry, T. W	Richmond & Danville	Richmond, Va.
George, Nathan M.		Danbury, Conn.
Gessler, Wm.	C. R. I. & P.	Trenton, Mo.
Gibbs, A. W	Central Georgia	Savannah, Ga.
Gibbs, George	C. M. & St. Paul	Milwaukee, Wis.

NAME	ROAD	ADDRESS
Gillis, H. A.	N. Y., L. E. & W.	Port Jervis, N. J.
Gilmore, W. L.	L. S. & M. S.	Elkhart, Ind.
Givan, F. A.	Ches. & Ohio	Huntington, W. Va.
Glasier, T. W.	Mexican Central	Silao, Mexico.
Gordon, H. D.		Juniata Shops, Altoona, Pa.
Glass, John C.	Allegheny Valley	Verona, Pa.
Glover, J. B.	Marietta & Nor. Ga.	Marietta, Ga.
Gordon, Jas. T.	Concord	Concord, N. H.
Graham, Chas.	D., L. & Western	Scranton, Pa.
Graham, J. S.	L. S. & M. S.	Cleveland, Ohio.
Greatsinger, J. L.	D. & I. Range	Two Harbors, Minn.
Griffin, B. F.	Dul. & I. Range	Two Harbors, Minn.
Griffith, Fred B.	D., L. & Western	Buffalo, N. Y.
Griggs, Albt.	New York & New England	Norwood, Mass.
Gugel, Daniel M.		Macon, Ga.
Hackney, Clem.		624 Washington Street, Milwaukee, Wis.
Hackney, George		Chicago, Ill.
Haggett, J. C.	D. & A. Valley	Dunkirk, N. Y.
Haggerty, G. A.	Canadian Pacific	McAdams Junction, N.B.
Hall, Don Diego	Government Railways	Santiago, Chili.
Hall, J. N.		Montgomery, Ala.
Haller, W. J.	Ches. & Ohio	Covington, Ky.
Ham, C. T.	Buffalo Steam Gauge Co.	Rochester, N. Y.
Hancock, Geo. A.	Atlantic & Pacific	Albuquerque, N. M.
Hanson, C. F.	Grand Trunk	London, Ont.
Harding, B. R.	R. G. R. & A.	Raleigh, N. C.
Harrington, John	Mexican Northern	Escalon, Mex.
Harris, Geo. D		
Harrison, W. H.	Balt. & Ohio	Newark, Ohio.
Haskell, B.	Northern Pacific	Missoula, Mont.
Hatswell, T. J.	F. & P. M	East Saginaw, Mich.
Hazelton, G. H	R. W. & O.	Oswego, N. Y.
Hazlehurst, G. B	Balt. & Ohio	Baltimore, Md.
Hassman, Wm	Chesapeake & Ohio	Huntington, W. Va.
Haynes, O. A.		St. Louis, Mo.
Hedley, E. M.	Elevated	98th Street, New York.
Hedley, F.	Kings County Elevated	Brooklyn, N. Y.
Hemphill, W. J.	Jacksonville South E.	Jacksonville, Ill.
Hendee, A.		Westinghouse Air Brake Co., Pittsburgh, Pa.
Henney, J. B.		93 Bird Street, Boston, Mass.
Heintzleman, T. W.	So. Pacific	Sacramento, Cal.
Herin, W. O.	M. K. & Texas	Parsons, Kan.

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Hickey, John	Northern Pacific	St. Paul, Minn.
Higgins, S	N. Y. P. & O.	Meadville, Pa.
Hill, Jas. W	Peoria & Pekin Union	Peoria, Ill.
Hinman, M. L	Brooks Locomotive Works, Dunkirk, N. Y.	
Hodgman, S. A	Lobdell Car Wheel Co., Wilmington, Del.	
Hoffecker, W. L	Central of New Jersey	Elizabethport, N. J.
Holman, W. L	Penn.	Renovo, Pa.
Homer, John C		Sta. C., Totton Place, Cincinnati, Ohio.
Hudson, E. E	C. C. C. & St. Louis	Cleveland, O.
Hufsmith, F	T. & G. N	Palestine, Tex.
Hughes, E. W. M		
Humphrey, A. L	Colorado Midland	Colorado City, Col.
Irby, Chas	K. C. F. S. & M	West Memphis, Ark.
Jackson, O. H	C. C. C. & St. L.	Brightwood, Ind.
Jacques, Richard	Hemenway & Brown, 87 Milk Street, Boston, Mass.	
Jennings, Wm	Mexican International	Piedras Negras, Mex.
Johns, C. T		Cleveland, Ohio.
Johnson, J. B	A. Midland	Helena, Ark.
Johnson, L R	Canadian Pacific	Vancouver, B. C.
Johnstone, F. W		City of Mexico.
Joughins, G. R.	Norfolk Southern	Berkley, Va.
Keeler, Sanford		East Saginaw, Mich.
Keith, J. M	Ferro-Caril Central	Tampico, Mexico.
Kiehner, John I	2341 E. York St	Philadelphia, Pa.
Kiley, M. R.	St. Jo. & G. I	St. Joseph, Mo.
Killen, W. E	Nevada Central	Battle Mountain, Nev.
Kells, Leroy	P. C. & St. L	Cincinnati, Ohio.
Kells, Ross	N. Y., L. E & W	New York.
Kimball, N. S	M. & Northern	Green Bay, Wis.
Kinsey, J. I	Lehigh Valley	Easton, Pa.
Knapp, G	H. & Shen.	Shenandoah, Ia.
Kulbaugh, I. N	Baltimore & Ohio	Pittsburgh, Pa.
Lannan, Wm	House of Representatives, Washington, D. C.	
Lape, C. F	Wabash.	Springfield, Ill.
Lape, J. K		
Lauder, J. N	Old Colony	Boston, Mass.
Lavery, W	N. Y., L. E. & W	Susquehanna, Pa.
Lawler, F. M	Cl., Cin., Ch. & St. L	Maltoon, Ill.

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Leach, H. L	1 Rollins Street, Boston, Mass.	
Leach, H. L., Jr	Fitchburg	Keene, N. H.
Leeds, Pulaski	L. & Nashville	Louisville, Ky.
Leigh, F. J	Canadian Locomotive Works, Kingston, Ont.	
Leonard, A. G	N. Y. Central	**New York City.**
Lewis, W. H	D. L. & Western	Kingsland, N. J.
Lewis, William H	C. B. & Northern	La Crosse, Wis.
Lloyd, T. S	Chesapeake & Ohio	Richmond, Va.
Logan, P. A	Canada Eastern	Gibson, N. B.
Losey, Jacob	Steam Forge Co., Louisville, Ky.	
Lumby, T. L	T. St. L. & K. C	Delphos, Ohio.
Luttgens, H. A	Rogers Locomotive Works, Paterson, N. J.	
Luttrell, J. W	N. N. & Miss. Valley	Paducah, Ky.
Lythgoe, Joseph	R. I. Locomotive Works, Providence, R. I.	
Macbeth, James	Adirondacks & Montreal	Herkimer, N. Y.
Macfarlane, T. W	Nor. Pacific	Mandan, N. Dak.
Mackenzie, John	N. Y. C. & St. L	Cleveland, Ohio.
Maglenn, Jas	Carolina Central	Laurenburgh, N. C.
Manly, Basil	A. & N. C	Newberne, N. C.
Manuell, Geo	Mobile & Ohio	Jackson, Tenn.
Marshall, E. S	St. L. A. & Tex	Pine Bluff, Ark.
Maver, A. A	Grand Trunk	Stratford, Ont.
May, Edward	Intercolonial	Moncton, N. B.
McClurg, John	Cl., Cin., Ch. & St. L	Urbana, Ill.
McConnell, J. H	Union Pacific	Omaha, Neb.
McCormick, J. R	C. & P. Sound	Seattle, Wash.
McCreery, Frank	Dayton & Ft. Wayne & C	Dayton, Ohio.
McCrum, J. S	K. C. Ft. S. & G	Kansas City, Mo.
McGrayel, John		Grand Junction, Ia.
McIntosh, W	Ch. & Northwestern	Winona, Minn.
McNaughton, Jas	Wis. Central	Waukesha, Wis.
McNiven, P. C	Canadian Loco. Works	Kingston, Ont.
McKenna, John	I. D. S	Indianapolis, Ind.
Medway, John	Fitchburgh	Mechanicsville, N. Y.
Meehan, James	C., N. O. & T. P	Ludlow, Ky.
Michael J. B	E. T. V. & Ga	Knoxville, Tenn.
Mills, Stott	Lehigh & Hudson	Warwick, N. Y.
Middleton, Harvey	Pullman Shops, Pullman, Ill.	
Midelton, Thomas	Government Railways	Sydney, N. S. W.
Millen, Thomas	New York City & N	High Bridge, N. Y.
Miller, E. A	N. Y. C & St. L	Conneaut, Ohio.
Miller, Geo. A	J. T. & K. W	Palatka, Fla.

NAME	ROAD	ADDRESS
Miller, W. H.	C. H. V. & T.	Columbus, O.
Minshull, E.	N. Y. O. & W.	Middleton, N. Y.
Minton, A. B.	Mobile & Ohio	Murphysboro, Ill.
Mitchell, A.	Lehigh Valley	Wilkesbarre, Pa.
Monkhouse, H.	C. R. I. & P.	Horton, Kan.
Montgomery, Wm.	C. of N. J.	Manchester, N. J.
Moore, J. H.		Port Jervis, N. J.
Morrell, J. E.	C., R. I. & P.	Davenport, Ia.
Morris, W. S.	C. & W. Mich.	Grand Rapids, Mich.
Morse, F. W.	Wabash	Ft. Wayne, Ind.
Morse, G. F.	Portland Locomotive Works, Portland, Me.	
Morse, W. M.	T. & O. C. E.	Marietta, O.
Mott, D. G.	Panama	Colon, Colombia.
Murphy, J. H.		
Murphy, P. H.	St. L., A. & T. H.	East St. Louis, Ill.
Nicholls, J. Mayne	Ferro Caril	Iquique, Chili, S. A.
Nichols, Edward	Brooks Locomotive Works, Dunkirk, N. Y.	
Noble, L. C.	A. French Spring Co.	Pittsburgh, Pa.
O'Brien, John	Richmond & Petersburg	Manchester, Va.
Olcott, H. P.		Coolidge, Kan.
Ortton, John	T., St. L. & K. C.	Delphos, O.
Page, H. D.	Chi. & Northwestern	Baraboo, Wis.
Pattee, J. O.	Great Northern	St. Paul, Minn.
Patterson, J. S		Cincinnati, O.
Paxson, L. B.	P. & Reading	Reading, Pa.
Peck, Peter H.	C. & W. I. & Balt.	Chicago, Ill.
Petrikin, C. L.	Union Iron Works	Selma, Ala.
Perry, F. A.	Cheshire	Keene, N. H.
Phelan, J. E.	Northern Pacific	Dickinson, Dak.
Pilsbury, Amos	Maine Central	Waterville, Me.
Pitkin, A. J.	Schenectady Locomotive Works, Schenectady, N. Y.	
Place, T. W.	Illinois Central	Waterloo, Ia.
Player, John	A., T. & S. Fè	Topeka, Kas.
Porter, Joseph S.	C., S. & C.	Sandusky, Ohio.
Prescott, C. H.	Spokane Falls & Northern	Spokane Falls, Wash.
Prescott, G. H.	T. H., I. & St. L.	Terre Haute, Ind.
Preston, D.	Canadian Pacific	Montreal, Can.
Price, William D.	P., A. & Western	Delphos, O.
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Pullar, John	Atlantic & Pacific	Winslow, Ariz.

NAME	ROAD	ADDRESS
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Quackenbush, A. W.	Chicago & Alton	Bloomington, Ill.
Quayle, Robert	M., L. S. & W.	S. Kaukauna, Wis.
Quinn, John A.	C., V. & C.	Mt. Carmel, Ill.
Ramsay, J. C.	Illinois Central	Memphis, Tenn.
Randolph, L. S.	Baltimore & Ohio	Baltimore, Md.
Ransom, T. W.	N. Y., L. E. & W.	Hornellsville, N. Y.
Rearden, Frank	Missouri Pacific	St. Louis, Mo.
Reed, W. T.	Chi., St. P. & K. C.	St. Paul, Minn.
Reid, M. M.	Norfolk Southern	Berkley, Va.
Reiley, B.	M. C. & F. D.	Ft. Dodge, Ia.
Rennell, Thomas	Little Rock & Memphis	Argenta, Ark.
Remex, B. H. De	Denver & Rio Grande	Leadville, Col.
Renshaw, W.	Illinois Central	Chicago, Ill.
Reynolds, W. W.	C., St. L. & P.	Columbus, Ohio.
Rhodes, G. W.	C., B. & Q.	Aurora, Ill.
Richardson, E.	S. & Allegheny	Shenango, Pa.
Richardson, R. M.	Missouri Pacific	Little Rock, Ark.
Rickard, C. W.		Sioux City, Ia.
Riley, G. M. D.	Sav., Fla. & Western	Savannah, Ga.
Robb, W. D.	Louisville & Nashville	Pensacola, Fla.
Roberts, E. M.	E. T., V. & Ga.	Atlanta, Ga.
Robertson, W. J.	Central Vermont	St. Albans, Vt.
Robinson, John	L. S. & M. S.	Buffalo, N. Y.
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Rossiter, C. W.	Northern Pacific	Duluth, Minn.
Russell, W. R.	Q., M. & C.	Quebec, Can.
Rutherford, William	Florida Southern	Palatka, Fla.
Ryan, I. I.	So. Pacific Co.	Houston, Tex.
Sample, N. W.	Denver & Rio Grande	Denver, Col.
Sanborn, C. A.		Carondelet, Mo.
Savage, R. W.	St. L., Ark. & Tex.	Tyler, Tex.
Schaeffer, Aug.	Maysville Water Works	Maysville, Ky.
Schlacks, Henry	Illinois Central	Chicago, Ill.
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Seward, J. P.	A. & B. Short Line	Annapolis, Md.
Setchel, J. H.	Pittsburgh Locomotive Works,	Allegheny, Pa.

NAME	ROAD	ADDRESS
Shafer, J. C.	Atlanta & Fla.	Atlanta, Ga.
Shaver, D. O.	Pennsylvania	Pittsburgh, Pa.
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Sheer, James M.	Ohio & Mississippi	Washington, Ind.
Sheerer, E. P.	Des Moines Union	Des Moines, Ia.
Shields, J. C.	Mineral Range	Hancock, Mich.
Silvius, E. T.	J., T. & K. W.	St. Augustine, Fla.
Sinclair, Angus		140 Nassau Street, New York.
Sitton, B. J.	Mexican National	Laredo, Tex.
Skinner, H. M. C	N. Y. Locomotive Works	Rome, N. Y.
Small, H. J	Southern Pacific	San Francisco, Cal.
Small, W. T		St. Paul, Minn.
Smart, C. E	Michigan Central	Jackson, Mich.
Smith, Allison D	Government	New Port, Victoria.
Smith, F. C		Delaware, Ohio.
Smith, Geo. W	A. T. & S. F	Topeka, Kan.
Smith, Howard M		Alexandria, Va
Smith, Wm	Boston & Maine	Boston, Mass.
Smith, Wm	Ch & Northwestern	Chicago, Ill.
Smith, W. T	New Port News & Miss. V.	Lexington, Ky.
Soule, R. H	Norfolk & Western	Roanoke, Va.
Sprague, H. N	Porter Locomotive Works	Pittsburgh, Pa.
Stapf, F. M		Mt. Carmel, Ill.
Stamelen, F	Erie & Huron	Chatham, Ont.
Stearns, W. H	Conn. River	Springfield, Mass.
Stephens, S. A	Rhode Island Locomotive Works,	Providence, R. I.
Stevens, Geo. W	L. S. & M. S	Cleveland, Ohio.
Stewart, O	Fitchburgh	Charlestown, Mass.
Stillman, H	S. D. & S. Pac.	Dunsmuir, Cal.
Stinard, F. A		8 Dickinson Street, Paterson, N. J.
Stokes, J. W	Ohio & Miss	Pana, Ill.
Stone, W. A	L. E. & St. L	Huntingburg, Ind.
Stout, Henry K	Pennsylvania	Sunbury, Pa.
Strode, James	N. Central	Elmira, N. Y.
Strom, L	Sonora	Guyamas, Mex.
Studer, A. L	C. R. I. & P.	Stuart, Ia.
Sullivan, A. W	Illinois Central	Chicago, Ill.
Sullivan, J. J	Louisville Southern	Harrodsburg, Ky.
Summerskill, T. A	Manitoba & N. West.	Portage La Prairie, Man.
Swanston, Wm	C. St. L. & P	Indianapolis, Ind.
Tandy, H	Brooks Locomotive Works,	Dunkirk, N. Y.
Teal, S. A	F. E. & M. V	Missouri Valley, Ia.

NAME	ROAD	ADDRESS
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Thomas, H. S	D. B. C. & A	East Tawas, Mich.
Thomas, W. H	E. T. V. & Ga.	Knoxville, Tenn.
Thomas, W. J	North P. Coast	Sausalite, Cal.
Thompson, C. A	Long Island	Richmond, Hill, N. Y.
Thompson, W. A	M. H. & O	Marquette, Mich.
Thow, Wm	Government	Sydney, N. S. Wales.
Torrence, John	E. & T. H	Evansville, Ind.
Tregelles, Henry	Norton Megaw's Co.,	Rio de Janerio, Brazil.
Tuggle, S. R	Kentucky Central	Covington, Ky.
Turner, Calvin G.	Phil., Wil. & Balt	Wilmington, Del.
Turner, Chas. E	W. N. Y. & Pa	Olean, N. Y.
Turner, J. S	Eames Vacum Brake Co.,	New York.
Turner, L. H	Pitt. & L. Erie	Chartiers, Pa.
Turreff, W. F	Erie	Cleveland, Ohio.
Twombly, A. W	Old Colony	Taunton, Mass.
Twombly Fred M	Old Colony	Boston, Mass.
Twombly, T. B		Chicago, Ill.
Tyerell, Thos. H	S. I. R. T	Whitehall Street, N. Y.
Tynan, F. F	Ferro Cariles Unido de la	Habana, Habana, Cuba.
Ulmo, H. A.	C. & Savannah	Savannah, Ga.
Underhill, A. B	B. & Albany	Springfield, Mass.
Vail, A.	W. N. Y. & Pa	Buffalo, N. Y.
Van Brunt, G. E	Penn. Northwestern	Bellwood, Pa.
Vauclain, S. M	Baldwin Locomotive Works,	Philadelphia, Pa.
Voss, William.	B. C. R. & N	Cedar Rapids, Ia.
Wakefield, S. W	C. R. I. & P.	Keokuk, Ia.
Walden, W. A	Richmond & Danville	Atlanta, Ga.
Walker, C. W	S & Roanoke	Portsmouth, Va.
Warwick, T. F	C. of Georgia	Augusta, Ga.
Wall, E. B	P. C. & St. L	Columbus, Ohio.
Wallis, Herbert	Grand Trunk.	Montreal, Can.
Wallis, J. M	Pennsylvania	Altoona, Pa.
Wallis, Philip	Norfolk & Western	Roanoke, Va.
Walsh, Thomas	L. & Nashville	Mt. Vernon, Ill.
Wanklyn, F. L	Grand Trunk.	Montreal, Can.
Ward, C. F	St. P. & D	St. Paul, Minn.
Warren, Beriah	T. P. & W	Peoria, Ill.
Warren, W. B	2808 Lafayette Avenue,	St. Louis, Mo.

NAME	ROAD	ADDRESS
Watts, Amos H	C. J. & M	Marshall, Mich.
Webb, F. W	L. & N. W	Crewe, England.
Webb, M. S	M. & Phoenix	Phoenix, Ariz.
Weisgerber, E. L	B. & Ohio	Newark, Ohio.
Wells, Reuben	Rogers Locomotive Works, Paterson, N. J.	
West, G. W	N. Y. O. & Western	Middleton, N. Y.
Wheeler, M. C	Central Iowa	Marshalltown, Ia.
White, A. M	Schenectady Locomotive Works, Schenectady, N. Y.	
White, E. P	C. N. & E	Cadillas, Mich.
Whitlock, Joseph	N. H. & D	Ansonia, Conn.
Whitney, H. A	Intercolonial	Moncton, N. B.
Whittington, E. J	Ch. & Alton	Slater, Mo.
Wightman, D. A	Pittsburgh Locomotive Works, Allegheny, Pa.	
Wilcox, W. J	C. C. C	Keokuk, Ia.
Williams, C. G	C. of N. J	Communipaw, N. J.
Williams, E. A	M. St. P. S. S. & M	Minneapolis, Minn.
Williams, R	N. Y. Locomotive Works, Rome, N. Y.	
Winslow, J. M	Todd Machine Co., Tacoma, Wash Ter.	
Wilson D. Ellis	Nitrate	Pisagua, Chili, S. A.
Wilson, G. F	C. R. I. & P	Chicago, Ill.
Wilson, John		1802 Ohio Street, Omaha, Neb.
Wyman, Jeffries	B. & Mo. River	Alliance, Neb.

ASSOCIATE MEMBERS.

NAME.	ROAD.	ADDRESS.
Barnes, D. L.		Rookery Building, Chicago, Ill.
Crosman, W. D.		Rookery Building, Chicago, Ill.
Dean, F. W.		53 State Street, Boston, Mass.
Forney, M. N.		17 E. 38th Street, New York.
Gordon, Alex.		Niles Tool Works, Hamilton, O.
Hill, John A.		96 Fulton Street, New York.
Hill, John W.		Glenn Building, Cincinnati, O.
Lyne, L. F.		307 Grove Street, Jersey City, N. J.
Marshall, W. H.		Rookery Building, Chicago, Ill.
Miles, F. B.	Bement & Miles	Philadelphia, Pa.
Pomeroy, L. R.		45 Broadway, New York, N. Y.
Shaw, Thomas		915 Ridge Street, Philadelphia, Pa.
Smith, John Y.		Doylestown, Pa.
Smith, W. A.		Rookery Building, Chicago, Ill.
Wheelock, Jerome		25 Elizabeth Street, Worcester, Mass.
Woods, A. T.		Washington University, St. Louis, Mo.

HONORARY MEMBERS.

NAME.	ROAD.	ADDRESS.
Black, John		Lima, O.
Coolidge, G. A.		Charlestown, Mass.
Divine, J. F.	W. & Weldon	Wilmington, N. C.
Dripps, Isaac		345 Walnut Street, Philadelphia, Pa.
Eddy, Wilson		Springfield, Mass.
Foss, J. M.	Central Vermont	St. Albans, Vt.
Jeffery, E. T.		1919 Michigan Avenue, Chicago, Ill.
Johann, Jacob		608 Phoenix Building, Chicago, Ill.
Mulligan, J.	Conn. River	Springfield, Mass.
Peddle, C. R.		Terre Haute, Ind.
Perrin, P. J.		Taunton, Mass.
Philbric, J. W.		Waterville, Me.
Richards, Geo.		14 Auburn Street, Roxbury, Mass.
Robinson, W. A.		Hamilton, Ont.
Sedgely, James		Cleveland, Ohio.
Sellers, Morris		Phoenix Building, Chicago, Ill.
Sheppard, F. L.	Pennsylvania	Altoona, Pa.
Thompson, John		137 Webster Street, East Boston, Mass.
Towne, H. A.		256 First Avenue, Minneapolis, Minn.
White, J. L.		Danville, Ill.
Williams, E. H.		Baldwin Locomotive Works, Philadelphia, Pa.

CONSTITUTION AND BY-LAWS.

ARTICLE I.

NAME.

The name of this Association shall be the AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

ARTICLE II.

OBJECTS OF ASSOCIATION.

The objects of this Association shall be the advancement of knowledge concerning the principles, construction, repair and service of the rolling-stock of railroads, by discussions in common, the exchange of information, and investigations and reports of the experience of its members; and to provide an organization through which the members may agree upon such joint action as may be required to give the greatest efficiency to the equipment of railroads which is entrusted to their care.

ARTICLE III.

MEMBERSHIP.

SECTION 1. The following persons may become active members of the Association, on being recommended by two members in good standing, signing an application for membership and agreement to conform to the requirements of the Constitution and By-Laws, or authorizing the Secretary to sign the Constitution for them :

(1.) Those above the rank of general foremen, having charge of the design, construction or repair of railway rolling-stock.

(2.) General foremen, if their names are presented by their superior officers.

(3.) Two representatives from each locomotive building works.

SEC. 2. Civil and mechanical engineers, or other persons having such a knowledge of science or practical experience in matters pertaining to the construction of rolling-stock as would be of special value to the Association or railroad companies, may become associate members on being recommended by three active members. The name of such candidate shall then be referred to a committee, to be appointed by the President, which shall investigate the fitness of the candidate and report to the Executive Committee of the Association at the next annual meeting. If the report be unanimous in favor of the candidate the name shall be submitted to ballot, and five dissenting votes shall reject. The number of associate members shall not exceed twenty, and they shall be entitled to all the privileges of active members, excepting that of voting.

SEC. 3. All members of the Association excepting as hereafter provided, shall be subject to the payment of such annual dues as it may be necessary to assess for the purpose of defraying the expenses of the Association, provided that no assessment shall exceed five dollars a year.

Such dues shall be payable when the amount thereof is announced by the President, at each annual meeting. Any member who shall be two years in arrears for annual dues, shall be notified of the fact, and if the arrears are not paid within three months after such notification, his name shall be taken from the roll and he be duly notified of the same by the Secretary.

SEC. 4. Any person who has been or may be duly qualified as a member of this Association will remain such until his resignation is voluntarily tendered, or he becomes disqualified by the terms of this Constitution. Members whose names have been dropped for non-payment of dues, may be restored to membership by the unanimous consent of the Executive Committee on the payment of all back dues.

SEC. 5. Members of the Association who have been in good standing for not less than five years, and who through age or other cause cease to be actively engaged in the mechanical department of railway service, may, upon the unanimous vote of the members present at the annual meeting, be elected Honorary Members. The dues of Honorary Members shall be remitted, and they shall have all the privileges of active members, except that of voting.

SEC. 6. Any member who, during the meetings of the Association, shall be guilty of dishonorable conduct which is disgraceful to a railroad officer and a member of the Association, or shall refuse to obey the chairman when called to order, may be expelled by a two-thirds affirmative vote at any regular meeting of the Association held within one year from the date of the offense.

ARTICLE IV.

OFFICERS.

SEC. 1. The officers of the Association shall be a President, a First Vice-President, a Second Vice-President, a Treasurer and a Secretary, and they shall constitute the Executive Committee.

ARTICLE V.

DUTIES OF OFFICERS.

SEC. 1. It shall be the duty of the President to preside at all the meetings of the Association, appoint all committees—designating the chairman, and approve all bills against the Association for payment by the Treasurer.

SEC. 2. It shall be the duty of the Vice-Presidents, according to rank, to perform the duties of the President in his absence from the meetings of the Association.

SEC. 3. In case of the absence of both President and Vice-Presidents, the members present shall elect a President *pro tempore*.

SEC. 4. It shall be the duty of the Secretary to keep a full and correct record of all transactions at the meetings of the Association; to keep a record of the names and places of residence of all members, and the name of the railway they each represent; to certify to the persons who are eligible as candidates for the Association's scholarships at the Stevens' Institute of Technology; to receive and keep an account of all money paid to the Association and deliver the same to the Treasurer, taking his receipt for the amount; to receive from the Treasurer all paid bills, giving him a receipted statement of the same.

SEC. 5. It shall be the duty of the Treasurer to receive all money from the Secretary belonging to the Association; to receive all bills and pay the same, after having approval of the President; to deliver all bills paid to the Secretary at the close of each meeting, taking a receipted statement of the same and to keep an accurate book account of all transactions pertaining to his office.

ARTICLE VI.

EXECUTIVE COMMITTEE.

SEC 1. The Executive Committee shall exercise a general supervision over the interests and affairs of the Association, recommend the amount of the annual assessment, to call, to prepare for, and to conduct, general conventions, and to make all necessary purchases, expenditures and contracts required to conduct the current business of the Association, but shall have no power to make the Association liable for any debt to an amount beyond that which at the time of contracting the same shall be in the Treasurer's hands in cash, but not subject to prior liabilities. All expenditures for special purposes shall only be made by appropriations acted upon by the Association at a regular meeting.

SEC. 2. The Executive Committee shall receive, examine and approve before public reading, all communications, papers and reports on all mechanical and scientific matters; they shall decide what portion of the reports, papers and drawing shall be

submitted to each convention and what portion shall be printed in the Annual Report.

SEC. 3. Three members shall constitute a quorum for the transaction of business.

ARTICLE VII.

ASSOCIATION SCHOLARSHIPS.

It shall be the duty of the Secretary to issue a circular annually intimating the date and place when and where candidates may be examined for the Scholarships of the Association in the Stevens' Institute of Technology, Hoboken, N. J.

Acceptable candidates for these scholarships are the sons of members of the association in good standing, the sons of honorary members and sons of deceased active or honorary members who may have died while in good standing. Candidates for these scholarships shall apply to the Secretary of this Association, and if found eligible shall be given a certificate to that effect for presentation to the school authorities. This will entitle the candidate to attend the preliminary examination. If more than one candidate passes the preliminary examination, the applicant passing the highest examination shall be entitled to the scholarship, the school authorities settling the question.

The candidates for these scholarships must have at least one year's experience in some recognized machine shop. The successful candidate shall also be required to take the course of mechanical engineering.

ARTICLE VIII.

ELECTION OF OFFICERS.

SEC 1. The officers of the Association shall be elected by ballot separately without nomination at the regular meeting of the Association held in June of each year. A majority of all votes cast shall be necessary to an election and elections shall not be postponed.

SEC. 2. Two tellers shall be appointed by the President to conduct the election and report the result.

ARTICLE IX.

AUDITING COMMITTEE.

SEC. 1. At the first session of each annual meeting an Auditing Committee, consisting of three members not officers of the Association, to be nominated by any member who does not hold office, shall be elected in the same way as officers are voted for. This Auditing Committee shall examine the accounts and vouchers of the Treasurer and certify whether they have been found correct or not. After the performance of this duty they shall be discharged by the acceptance of their report by the Association.

COMMITTEE ON SUBJECTS FOR INVESTIGATION AND DISCUSSION.

SEC. 2. At each annual meeting the President shall appoint a committee whose duty it shall be to report at the next annual meeting subjects for investigation and discussion, and if the subjects are approved by the Association the President, as hereinafter provided, shall appoint committees to report on them. It shall also be the duty of the committee to receive from members questions for discussion during the time set apart for that purpose. This committee shall determine whether such questions are suitable ones for discussion, and if so, they shall so report them to the Association.

COMMITTEES ON INVESTIGATION.

SEC. 4. When the Committee on Subjects has reported, and the Association approved of subjects for investigation, the President shall appoint special committees to investigate and report on them, and may authorize and appoint a *special* committee to investigate and report on any subject which a majority of the members present may approve of.

ARTICLE X.

AMENDMENTS.

SEC. 1. This Constitution may be amended at any regular meeting by a two-third vote of the members present, provided that written notice of the proposed amendments has been given at a previous meeting at least six months before.

BY-LAWS.

TIME OF MEETING.

I. The regular meeting of the Association shall be held annually on the third Tuesday in June.

HOURS OF SESSION.

II. The regular hours of session shall be from nine o'clock A. M. to two o'clock P. M.

PLACE OF MEETING.

III. "Places for holding the Annual Convention may be proposed at any regular meeting of the Association. Before the final adjournment the places proposed shall be submitted to a vote of the members, and within six months thereafter the Executive Committee shall select a place from the three which have received the highest number of votes."

QUORUM.

IV. At any regular meeting of the Association fifteen or more members entitled to vote shall constitute a quorum.

ORDER OF BUSINESS.

V. The business of the meetings of this Association shall,

unless otherwise ordered by a vote, proceed in the following order:

1st. Opening Prayer.
2d. Address by the President.
3d. Calling the roll.
4th. Acting on the minutes of the last meeting.
5th. Reports of Secretary and Treasurer.
6th. Assessment and announcement of annual dues.
7th. Election of Auditing Committee.
8th. Unfinished business.
9th. New business.
10th. Reports of committees.
11th. Reading of papers and discussion of questions propounded by members.
12th. Routine and miscellaneous business.
13th. Election of officers.
14th. Adjournment.

QUESTIONS FOR DISCUSSION, SPECIAL ORDER OF.

VI. Unless otherwise ordered, the discussion of questions proposed by members shall be the special order from 12 o'clock M. to 1 P. M. of each day of the annual meeting.

DECISIONS.

VII. The votes of a majority of the members shall be required to decide any question, motion or resolution which shall come before the Association unless otherwise provided.

DISCUSSIONS.

VIII. No patentees or their agents shall be admitted in the meetings of the Association for the purpose of advocating the claims of any patent or patentee, unless by unanimous consent.

IX. No member shall speak more than twice in the discussion of any question until all the other members who want to speak and have not been heard have spoken.

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